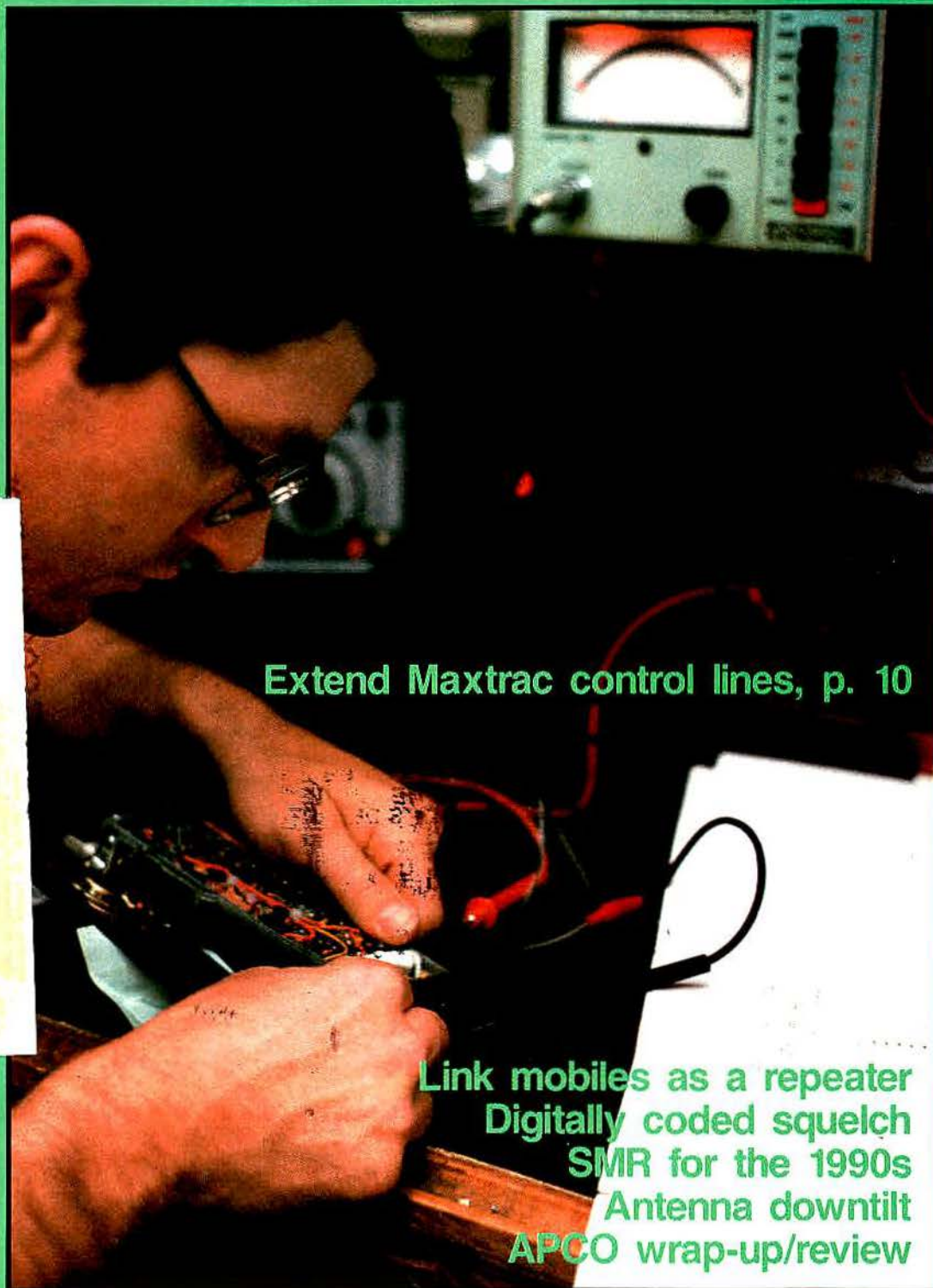


November 1990/\$3.00

Mobile Radio Technology

The journal of mobile communications technology



Extend Maxtrac control lines, p. 10

Link mobiles as a repeater
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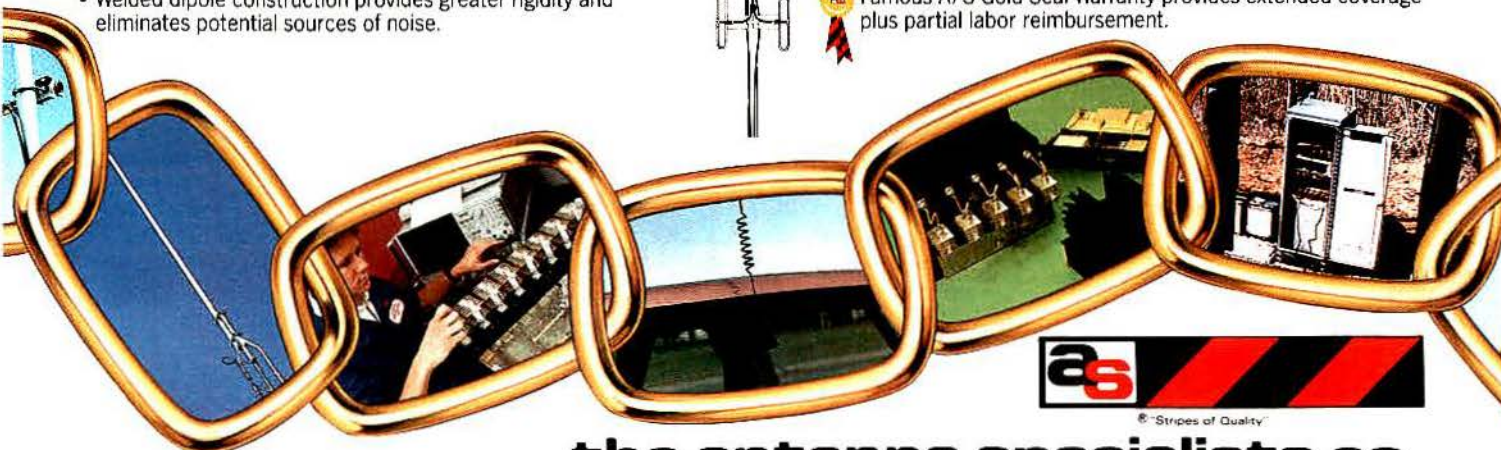
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features

10 Extended control of Maxtrac radio

Harold Kinley, CET

Maxtrac control lines may be extended to a length of 1,300 feet, avoiding the need for remote control.

24 How to link mobiles to form a repeater

Carlton L. Tedrick, P.E.

Two Motorola Maxtrac radios covert for repeater operation.

28 APCO wrap-up/review

Don Bishop and Jane Bryant

Washington representation and spectrum relief are the association's top priorities.

42 Specialized mobile radio makes ready for the 1990s

Robert C. Shapiro, P.E., Decibel Products

High-power, single-site analog SMR systems may give way to multisite, low-power digital 'ESMR' systems.

46 Digitally coded squelch: What makes it work—or fail

Mark Nadir, Globestar Technology

Understanding of codeword construction helps to unravel some of the mysteries.

62 Use downtilt selectively to improve system coverage

Andrew Singer, Sinclair Laboratories

Use a handy computer program to calculate coverage areas for antennas with downtilt.

departments

4 Editorial

6 Letters to the editor

Using scanners.

68 News

Four radio paging carriers join Telocator.

72 ACT update

Association membership combines tangible, intangible benefits.

73 Regulating technology

RCCs win power and antenna height increases.

74 New products

Yaesu, AOR, Motorola and Mobile Mark are the "Readers' Choice."

92 Literature

94 Feedback

The '90s: stiff competition.

97 People

Antenna Specialists has a new president.

98 Calendar

Radio Club of America meets Nov. 16.

99 Classified ads

112 Ad index/hotline

Find advertisers quickly.

113 What do you think?

What test methods do you prefer?

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On the cover: Pat Hammack, a technician with Communications Maintenance, Indianapolis, repairs a portable two-way radio transceiver.

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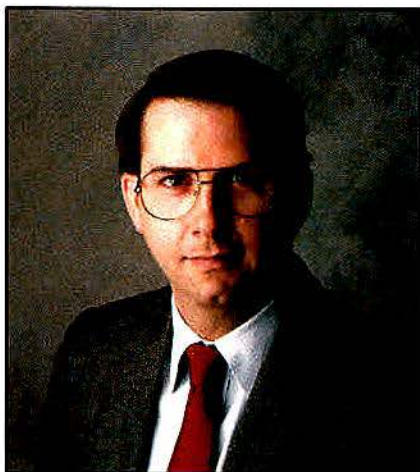
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Circle (5) on Fast Fact Card



Scanning . . .

Electronic filing

Congratulations go to the Associated Public-Safety Communications Officers (APCO); the FCC's Office of the Managing Director and the Private Radio Bureau; and APCO's contractor, CET, for a successful test of an electronic method of filing radio license applications.

Staff members at APCO, CET and the FCC worked together on a pilot project to configure computer hardware and software to transfer license applications via wire from APCO's New Smyrna Beach, FL, headquarters to the FCC.

The electronic filing procedure holds the promise of greater speed and fewer errors. It puts in place additional capabilities for the private sector to handle more responsibility if and when the government finds it necessary to trim its level of service in response to budget cuts.

Individuals who deserve credit for being instrumental in developing and testing the electronic filing capability include:

- **FCC**—Ralph A. Haller; Andrew S. Fishel; Michael J. Gilbride; John M. Giuli; Chanel DeVane; John Chudovan; and Judith Lear.

- **APCO**—Don R. Precure; Alireza Shahnam; Cheryl Harrer; Chris Phelps; Jean McBride; and Maureen Kovatch.

- **CET**—Nancy Davis and Chris Davis.

Conditional licensing

It was two years in the making, but conditional licensing is here! Using FCC Form 572C, many applicants for private land mobile two-way radio licenses can go on the air after their applications have been processed by a frequency coordinator and before a permanent license is issued by the FCC. Not having to wait for the permanent license before activating a new radio system offers many benefits:

- (1) It helps two-way radio communications dealers compete. Once customers are ready to take advantage of radio communications, they do not have as long to wait before putting their new equipment into use. The speedier serv-

ice dealers can offer, thanks to conditional licensing, helps them with their sales efforts.

- (2) It encourages compliance with radio regulations. Face it, some systems go on the air without licenses and, perhaps even worse, without frequency coordination, because the wait for a license was too long. Conditional licensing won't turn lawbreakers into law-abiding citizens, but it may help to discourage the practice of placing radio transmitters on the air before they are licensed.

- (3) It prepares the two-way radio industry for a future in which federal budget difficulties may work against the FCC Private Radio Bureau Licensing Branch's efforts to process applications quickly. Present turnaround times may extend into months if money becomes too short to ensure speedy license application processing. Conditional licensing removes much of the risk for economic harm that otherwise accompanies the prospect of extended delays in the issuance of permanent business and industrial radio communications licenses.

Public safety radio service applicants benefit, too, but their concerns generally have less to do with the economic effects of licensing delays. Some public safety officers tell us, in fact, that the speed with which their licenses are issued may be less important than the actual and eventual access to a sufficient number of frequencies.

Not every proposed radio facility may be activated under terms of a conditional license, but many can be. Conditional licensing is good news for the radio communications industry.

—Don Bishop

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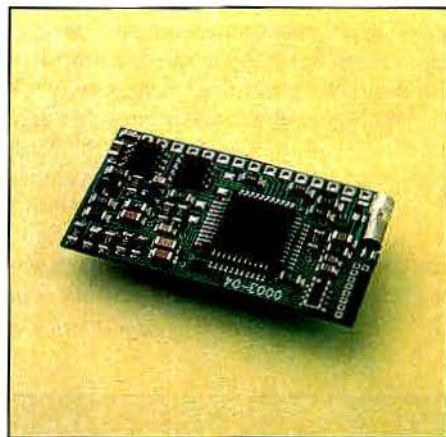
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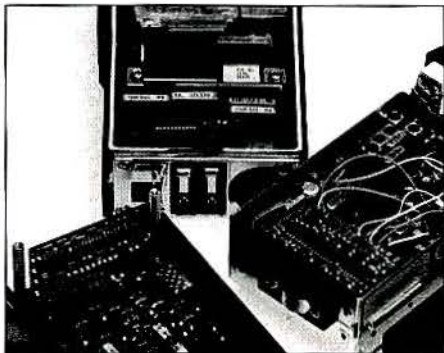
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From Fast Fact Cards:

The toughest problem on the job is the long delay in receiving orders of antennas and support parts. Back orders are a common concern. Manufacturers seem interested in sales as a No. 1 priority; service literature and parts are last on their lists.

Clayton G. Langevin
Communications Technician
Ministry of Natural Resources
Tweed, Ontario

The toughest problem is keeping UHF portables used in the power plant in good shape.

I spend a fair amount of time keeping VHF mobiles in top shape so they can communicate from the hilly terrain in our area.

Lyle A. Nyffeler
Communications Technician
St. Joseph Power & Light
St. Joseph, MO

There are too many "non-field-reparable" subassemblies. There are so many to stock, and they are so expensive. It is getting tougher to have what is needed for repairs at remote sites.

Len Werman
Field Technical Director
Utah Communications
Salt Lake City

Your June issue is pretty good overall, but I like to read law enforcement-oriented communications articles.

How about an article on listening to (scanning) cellular and other bands and the laws governing such activity? Are mobile scanners illegal in some areas?

Richard A. Massie
Electronics Technician
Quantico, VA

Listening to cellular mobile telephone conversations without a warrant is prohibited under the 1987 Electronic Com-

munications Privacy Act. We oppose the act as it applies to monitoring radio communication.

First, receiver use should not be restricted.

Second, unenforceable law is not good law. To enforce the law as it applies to most scanner users, enforcement officials must take steps that are virtually impossible:

(1) A prosecuting attorney must persuade a judge to issue a search warrant on the basis that there is probable cause that someone is using a scanner to listen to unauthorized frequencies.

(2) Armed with the search warrant, a law enforcement officer must enter a residence or business where the scanner is being used and catch the listener in the act of receiving signals on protected frequencies for which he has no license.

(3) If the listener does not admit he has broken the law in a confession ac-

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The journal of mobile
communications technology

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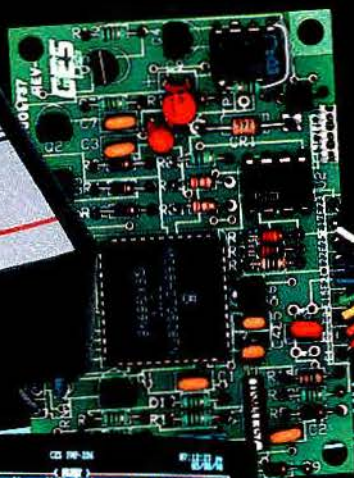
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Letters to the editor

ceptable to the court, the prosecutor must prove that the reception observed by the officer was intentional.

Our opposition to the law notwithstanding, we are not going to publish information about using scanners to hear cellular mobile telephone calls.

As for your second question, mobile scanners are illegal in some areas for some people. In some areas where mo-

bile scanner use is prohibited, exceptions have been made for news organizations and radio amateurs. You should check with your local and state authorities. —DB

The toughest problem is the lack of technical support from the manufacturing companies on the extremely complex systems such as mobile data and

INTRAC. When the system does not work, no one can even tell you where to start looking for the trouble.

Keith Mathers
Lead Technician
Canyon State Communications
Show Low, AZ

Manufacturers do not seem to want small dealers. They will not support a dealer unless the dealer has large facilities. Many small dealers are good technicians and can be quite loyal to a manufacturer who will support them.

Dale Hughes
Hughes Electronics
Juneau, AK

Is the East Coast dead?

The only job recruiting advertisements are from west of the Mississippi (or from Florida).

Name Withheld

Go west, young man. Or 'way south.
—DB

The July issue was good, as are all your issues. I really enjoy this publication. It keeps me current and "in tune." Thank you very much.

Please—more technical articles such as "How Analog Scrambling Fits Tactical Security Needs."

The two toughest problems facing me on the job are:

- (1) Updating NABER's database for them.
- (2) Customers who think they always have a so-called "five-minute" repair job.

Ron Tatum
Tatum Technology
Hopkinsville, KY

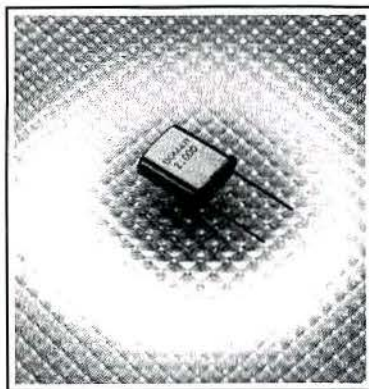
The toughest problems on the job include:

- (1) teaching people how to operate new radios to get the most out of their capabilities.
- (2) finding and correcting intermod problems.

Kit Orlosky
Principal Electronics Technician
State of Colorado
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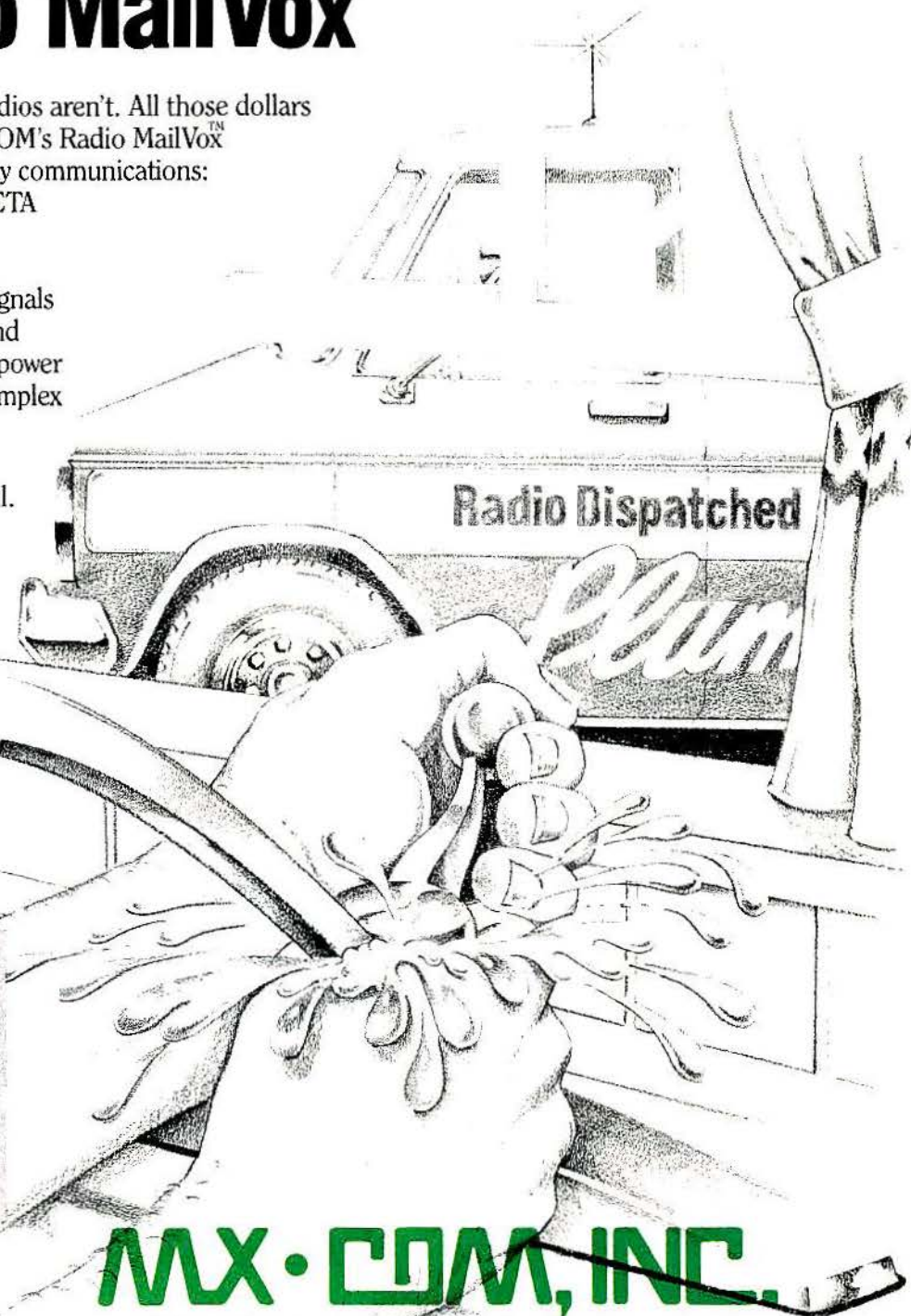
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Circle (9) on Fast Fact Card

Extended control of Maxtrac radio

When radios must be placed at distances from their control points, extended control may serve in place of remote control to save costs. An interface box implements the necessary technical modifications.

By Harold Kinley, CET

Sometimes it is necessary or desirable to use a radio or other electronic equipment in a situation for which it is not specifically designed. Usually this requires some special means to *adapt* the equipment to the special application.

There are several reasons why it may be desirable to adapt equipment to meet a special need:

(1) *Availability*—Special equipment to fill the need may not be readily available or there may be equipment on hand that, with some adaptation, will suit the purpose.

(2) *Cost*—It may be less expensive to adapt certain equipment to special needs than to purchase ready-to-use equipment.

(3) *Redundancy*—By using the same type of equipment that already is part of the system, the need for spare parts and spare radio equipment, as well as special test and programming accessories, is reduced.

For all these reasons, a decision was made to adapt a Motorola Maxtrac 300 mobile radio to use as a base station at a lookout tower on an experimental basis. The primary purpose was to gain multichannel wideband capability.

Requirements

Most of the South Carolina Forestry Commission's towers are provided with

adjacent living quarters. Radio control is required in the tower cab and the house. If the distance between the house and tower is no more than a few hundred feet, *extended* control is used. Extended control is much less expensive than using *remote* control equipment at each location.

The radio set is installed inside a weatherproof box at the tower base; the antenna is mounted on the tower. Control lines run to the house and tower cab to control the radio from both locations. Custom-built radio control boxes are installed in the house and tower cab. These custom radio control boxes usually are built into a speaker baffle.

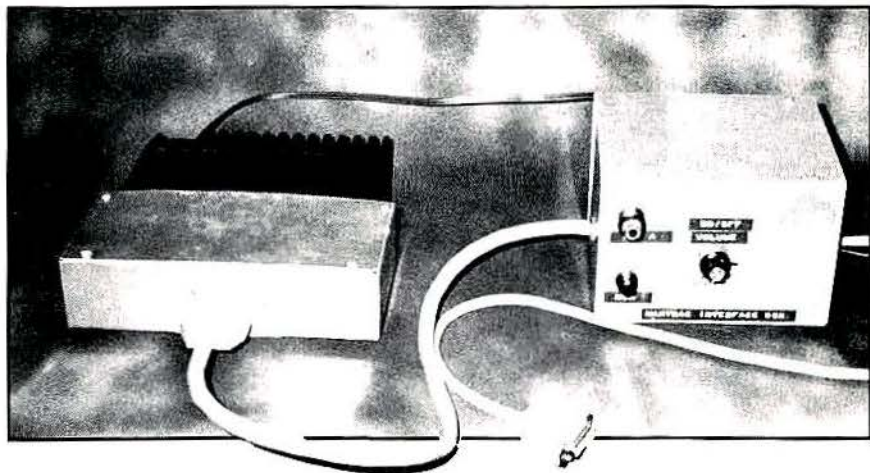
The experiment has some possible drawbacks. For example, the Maxtrac 300 has a *wide open* front end—about 40MHz wide, according to the manual. Because carrier squelch is used, the

radio's susceptibility to interference could be a serious drawback in some locations. But in rural areas, where most lookout towers are, interference may not be too severe. Furthermore, we expect to use continuous-tone coded squelch (CTCSS) in the future, so any *nuisance* interference will be eliminated.

Maxtrac 300

The Maxtrac 300 is a 16-channel wideband mobile radio. The frequencies, Private Line (PL or CTCSS) data, slaved-scan modes and other pertinent operational data are programmed via an IBM PC computer. Although the control head may be detached, the radio strictly is designed for dash mounting.

The control head attaches to the radio with two screws in front. The control head connects to the radio with two plugs, one for the *display* board and one



An interface head fitted to a Maxtrac radio (left) leaves the radio unmodified. The interface box allows control lines to extend as far as 1,300 feet.

Kinley is a certified electronics technician with the South Carolina Forestry Commission, Spartanburg, SC. His book is *Standard Radio Communications Manual With Instrumentation and Testing Techniques*, Prentice-Hall, 1985.

for the switch board. (See photo at the left.)

The block diagram shown in Figure 1 below shows the display board and the switch board connections to the radio. Both are simple and straightforward.

To study the operation of the display

board, examine Figure 2 on page 12. U1101 is a serial input shift register latch. Display data are feed into U1101 via the *serial data* input through pin 10 of P9. The serial data are clocked in by clock pulses on the *serial clock* line through pin 11 of P9. Once the data are

clocked in, a pulse appears on the *display enable* line (pin 2 of P9).

Output pins of U1101 on the left side connect to various display segments and to two other light-emitting diodes (LEDs)—the amber (monitor) LED and the green (priority) LED. To light an

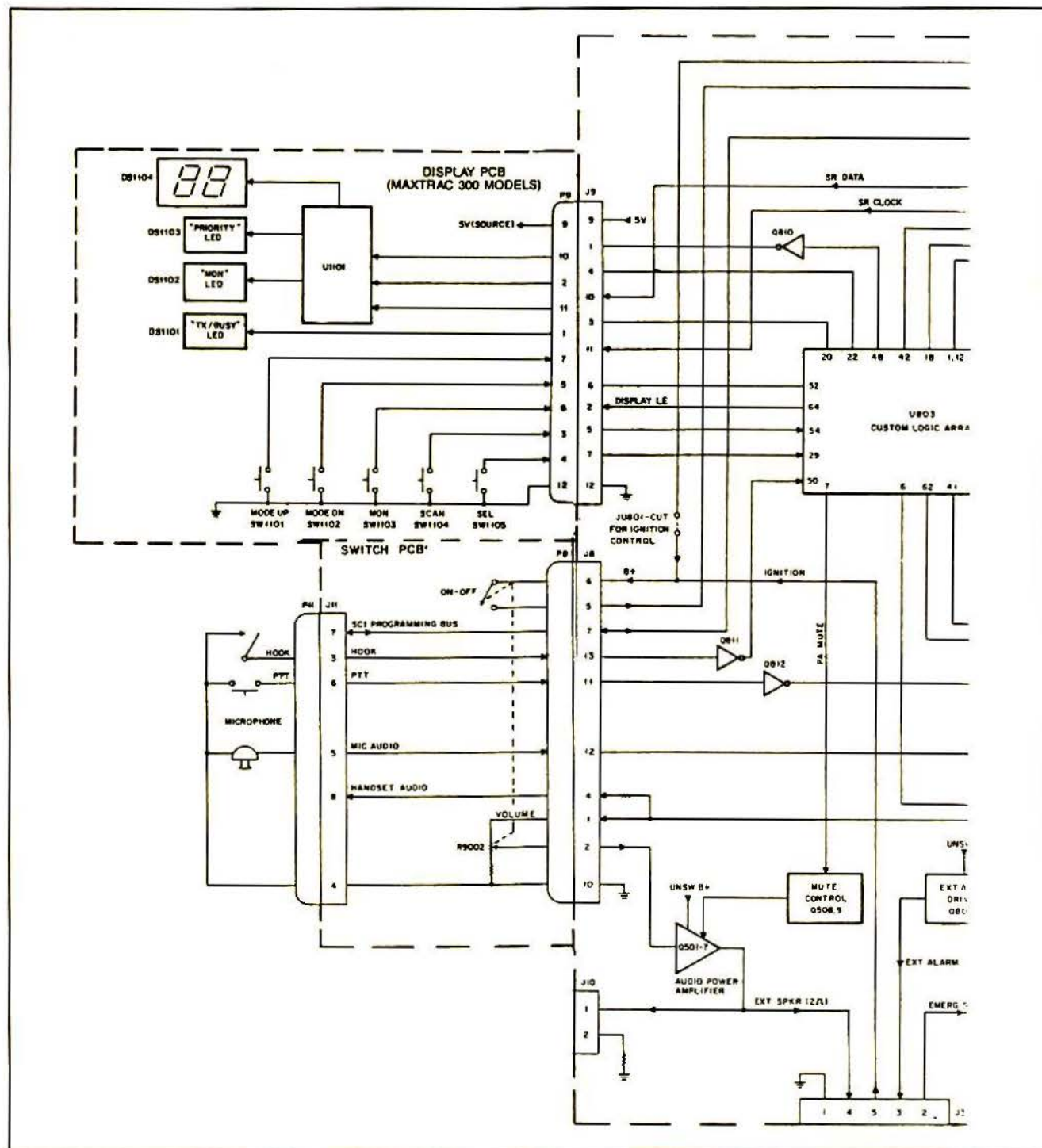


Figure 1. The block diagram shows the display board and the switch board connections to the radio. Both are simple and straightforward.

LED or segment, the shift register latch must place a *low* on (or ground) the 270Ω resistor connected to the segment. Output pins feeding unlit segments or LEDs remain *high*. The only LED not controlled by the shift register latch is the *transmit/busy* LED.

Five pushbutton switches are associated with the display board. The five switches' functions are *mode up*, *mode down*, *monitor*, *scan* and *select*. Pullup resistors R1118-R1122 connect to the five control lines to keep the lines *high*. When a pushbutton is pressed, a *low* temporarily is placed on the line. Thus, the control lines are said to be *active low*.

Having studied the control head wiring in detail, first it was decided simply to connect the two control heads in

parallel. It did not appear as though any harm would result. The connection was made with an experimental breadboard.

At first, this simple arrangement appeared to be all that was necessary. It worked fine. But long control lines exhibit shunt capacitance. Shunt capacitance can play havoc with digital pulses of the type used to load the display register.

To simulate a long cable's shunt capacitance, capacitors were connected to the three lines feeding the digital signals to the shift register. As the shunt capacitance was increased beyond 6,000pF, digital information transfer was affected. The seven-segment display became garbled (incorrect segments lit).

Lines that connect the radio to the house and tower exhibit a shunt capac-

itance of approximately 15pF per foot. Thus, a 6,000pF maximum allowable shunt capacitance limits the maximum cable length to about 400 feet for house and tower cables combined. That limit is too close to the actual length for reliability to be assured, so another means was required to extend the usable length of control lines.

During a telephone conversation, a Motorola engineer explained that the outputs from the microprocessor to the display register are not buffered. If the outputs were buffered, then it would be possible to feed the digital signals over longer lines without adverse effects. The remaining problem seemed to be one of finding the right buffer to handle the job.

Fortunately, the second buffer tried

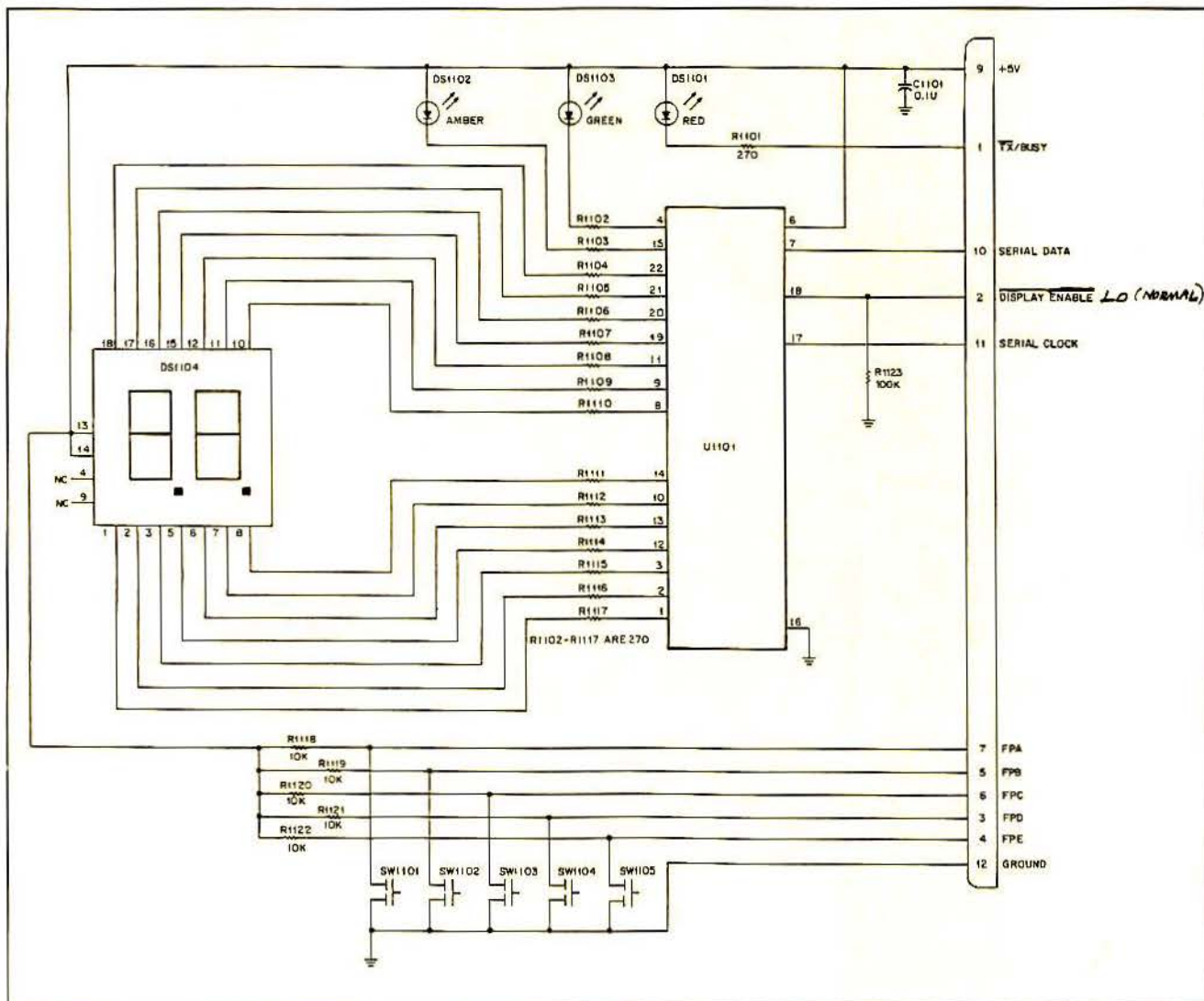


Figure 2. Display board operation is described in the text, with reference to this diagram.

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did the trick. It was a 74C902 CMOS hex non-inverting TTL buffer, a 14-pin dual in-line package (DIP) IC.

With this IC connected between the microprocessor outputs and the display register inputs, the display worked well with a simulated shunt capacitance of much more than 20,000pF. This capacitance is equivalent to a cable length of more than 1,300 feet, a length that would accommodate almost any of the forestry commission's house-and-tower configurations.

With the solution in hand, all that remained was to build the necessary interface box with the hex buffer and other circuitry.

Because the existing underground cable had only 12 wires plus a copper shield, it was necessary to work within

the limits imposed by 12 conductors. This limit required the sacrifice of some available functions. Because only eight channels were to be used, the *channel-down* function was eliminated. Stepping through the various channels could be done only with the *channel-up* function—an inconvenience, but not a big problem.

The *monitor* function was sacrificed with no great loss.

The *select* function, which changes the scanner setup from the front panel, was sacrificed. This function might have been deleted even if sufficient control wire capacity were available because it really is not desirable to have the tower attendant modify the scan setup. If the scan setup needs to be changed, it can be done by the radio technician by tem-

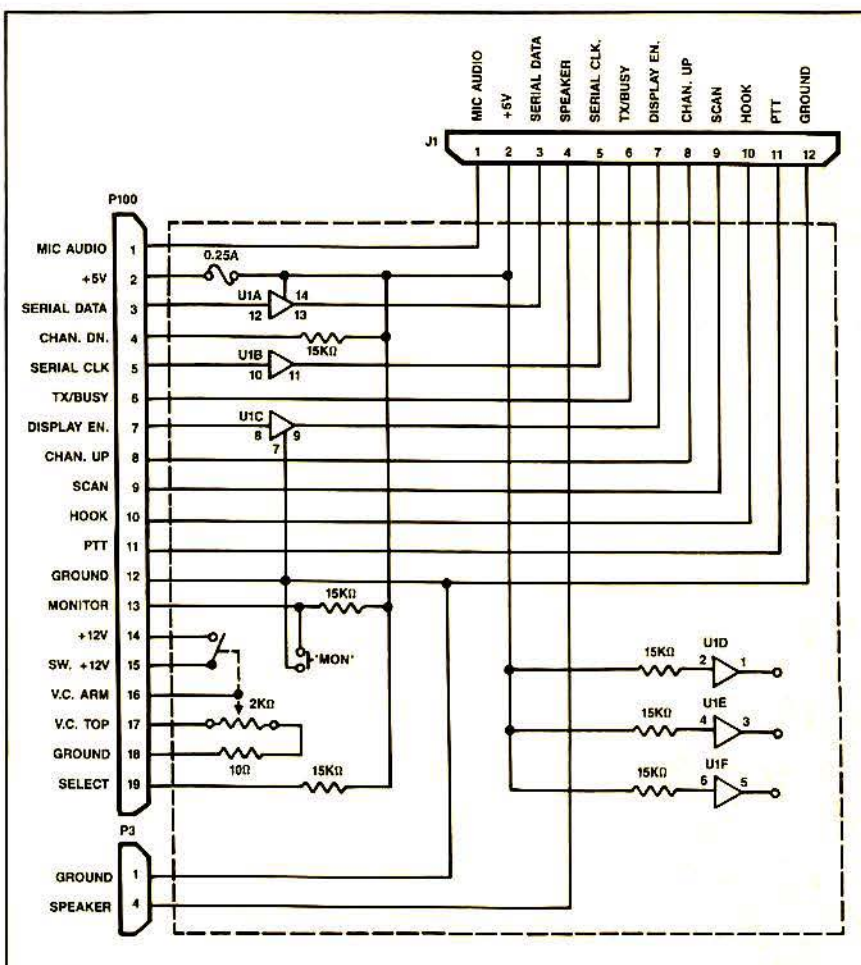
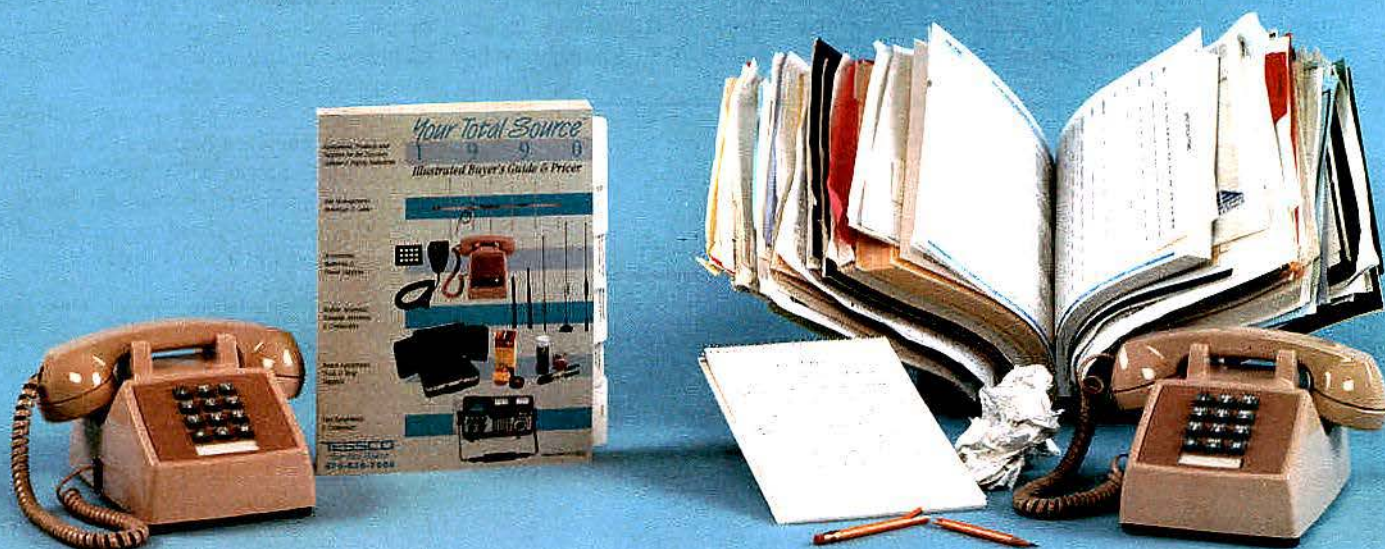


Figure 3. The interface box wiring details. Notice that only three of the buffers are used. The three remaining buffer inputs are tied to +5V. Notice that the three unused control functions (*channel-down*, *monitor* and *select*) are tied to +5V through a 15K resistor. This keeps them from floating. A *monitor* pushbutton is provided on the interface box as an aid to the service technician in unsquelching the receiver when testing at the radio box.

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porarily connecting a standard control head to the radio and making the necessary changes.

Figure 3 on page 14 shows the *interface* box wiring details. One of the 74C902's buffers is inserted into each line over which digital pulses are sent to the display register (U1101) in the control heads. These lines are *serial data*, *serial clock* and *display enable*. Because

of the buffer's low output impedance, it can overcome the long control lines' heavy capacitive loading effects and deliver a digital pulse with little distortion to the load end of the line.

Notice that only three of the buffers are used. The three remaining buffer inputs are tied to +5V. Some references say that unused CMOS device inputs should be tied to VCC; others say to tie

them to ground or VCC. The important thing is that they not be left *floating*. Floating inputs can cause a problem.

Notice that the three unused control functions (*channel-down*, *monitor* and *select*) are tied to +5V through a 15K resistor. This keeps them from floating. A *monitor* pushbutton is provided on the interface box as an aid to the service technician in unsquelching the receiver when testing at the radio box.

The on-off switch and volume control are on the interface box, too. The volume is set to produce 5W audio output to feed the lines to the house and tower.

P100 is a 25-pin D-sub connector of the type used for RS-232 applications.

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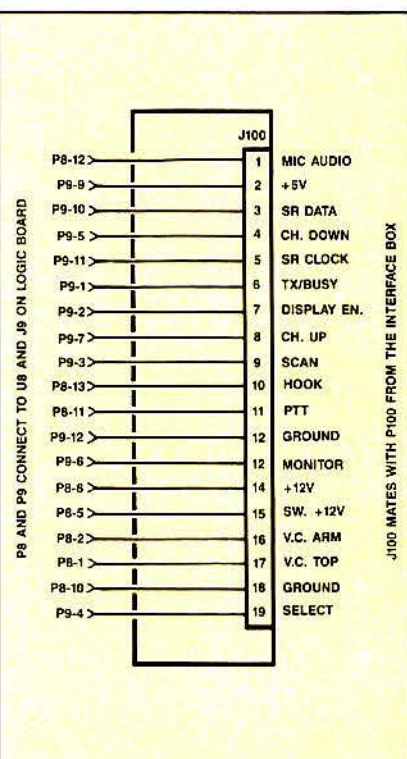
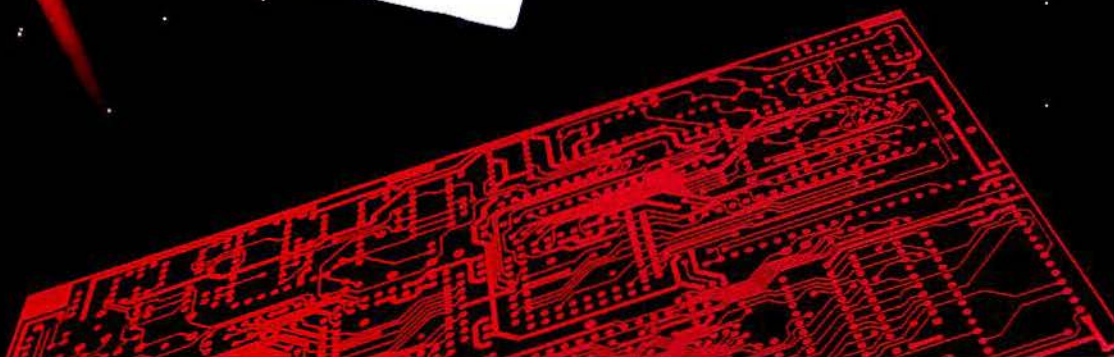


Figure 4. This diagram shows the interface head wiring. The interface head replaces the standard control head on the front of the radio.

J1 is a 15-pin D-sub connector. P3 is a special connector that mates with J3 on the rear of the Maxtrac 300. P100, P3 and J1 are in-line, rather than panel-mounted, connectors. Wiring within the interface box is done on a Radio Shack *universal* board, catalog no. 276-168. On the figure, the wiring is shown within the dashed lines.

Figure 4 above shows the *interface*



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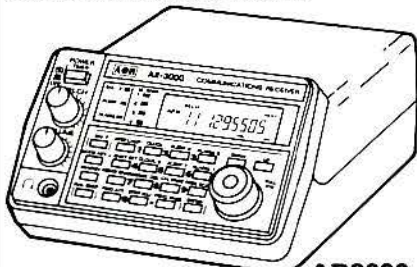
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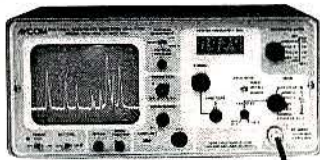
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head wiring. The interface head replaces the standard control head on the front of the radio. *J100* is a 25-pin D-sub connector that mates with *P100* from the interface box. Wires from *P8* and *P9* connect to *J100*. *P8* and *P9* connect to *J8* and *J9* on the Maxtrac 300 logic board. The interface head is built into a BUD box that, with a little modification and persuasion, fits tightly around the Maxtrac 300 radio. This tight fit helps to discourage those little "crawly creatures" that often inhabit outside radio boxes from making their home inside the radio.

Radio box wiring is shown in Figure 5 below. Three 12-terminal, barrier-type terminal strips are mounted on a plywood panel. Connections from the interface box, the house control cable and the tower control cable are made to these terminal strips.

Notice that two of the control lines are switched from house to tower. These are

This tight fit helps to discourage those little 'crawly creatures'... from making their home inside the radio.

the *hook* and *push-to-talk* (PTT) functions. The hook line must be interrupted to prevent the microphone at one control point from maintaining a ground on the line when the microphone is lifted from the hook at the opposite control point. The PTT line is switched so the transmitter may be keyed only from

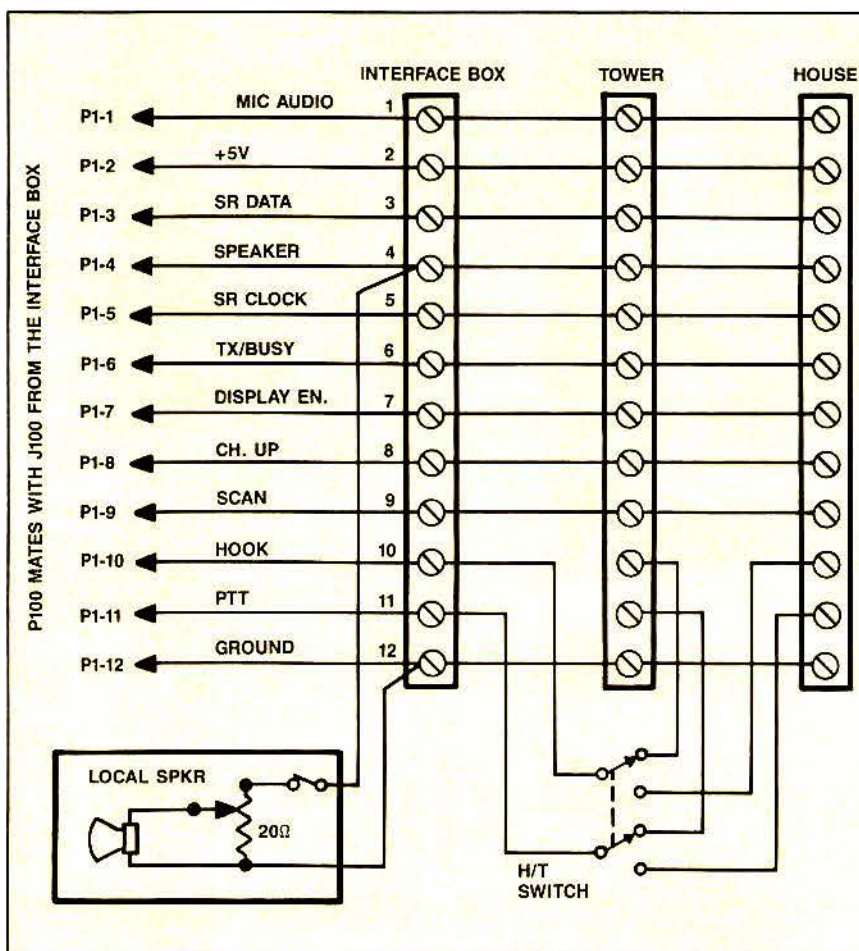


Figure 5. This diagram shows the radio box wiring. Notice that two of the control lines are switched from house to tower. These are the *hook* and *push-to-talk* (PTT) functions.

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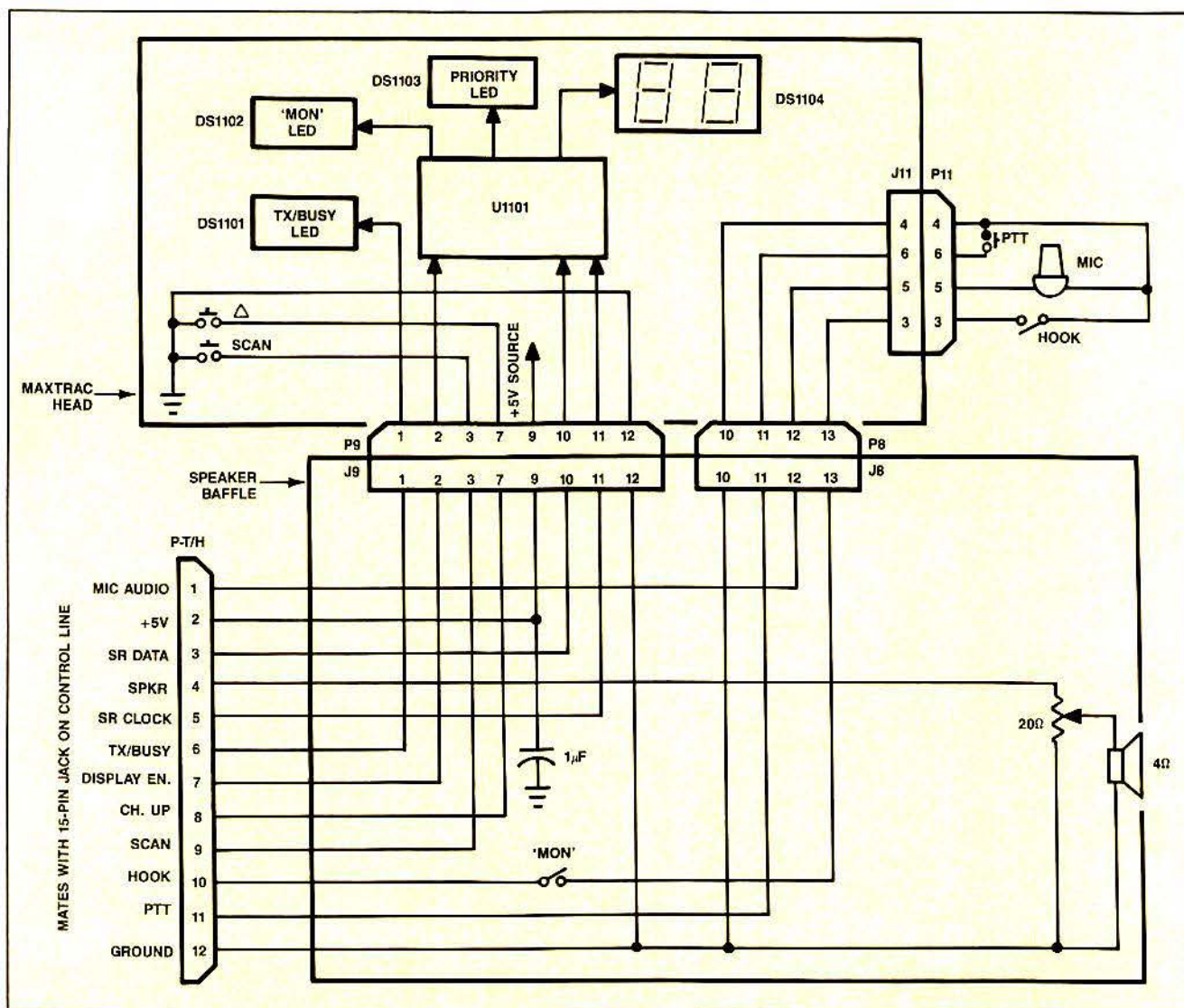
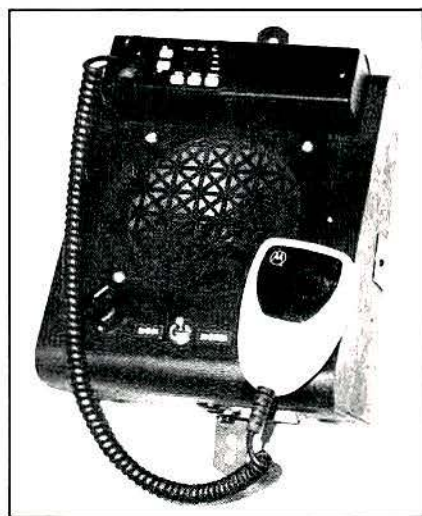


Figure 6. The wiring of the control box (one each for house and tower) uses a 20Ω potentiometer to set the volume. The 'MON' switch simply breaks the 'hook' line, allowing the operator to monitor without removing the microphone from the hook.



one control point, as determined by the switch position. This measure is precautionary.

The wiring of the control box (one each for house and tower) is shown in Figure 6 above. A Maxtrac control head is attached to a large speaker baffle. A 6-inch speaker is used instead of the small speaker inside the control head. A 20Ω potentiometer sets the volume. The "MON" switch simply breaks the "hook" line, allowing the operator to monitor without removing the microphone from the hook. See photo at the left.

A control box with a selection of buttons and switches connects with the distant interface box to control the Maxtrac radio.

Figure 7 on page 22 shows an overall functional block diagram. A 20A, 12V regulated power supply powers the Maxtrac 300 radio. The individual pieces of equipment shown within the dashed lines are located inside the outdoor radio box. These include the power supply, radio set and interface box. Not shown is a local test speaker located within the outdoor radio box.

High audio levels fed over the common ground wire caused some interference with the display. If enough control wires were available, this problem could have been solved by using a separate ground for the receiver audio. Instead, it was solved by using the heavy copper shield to provide a better, common,

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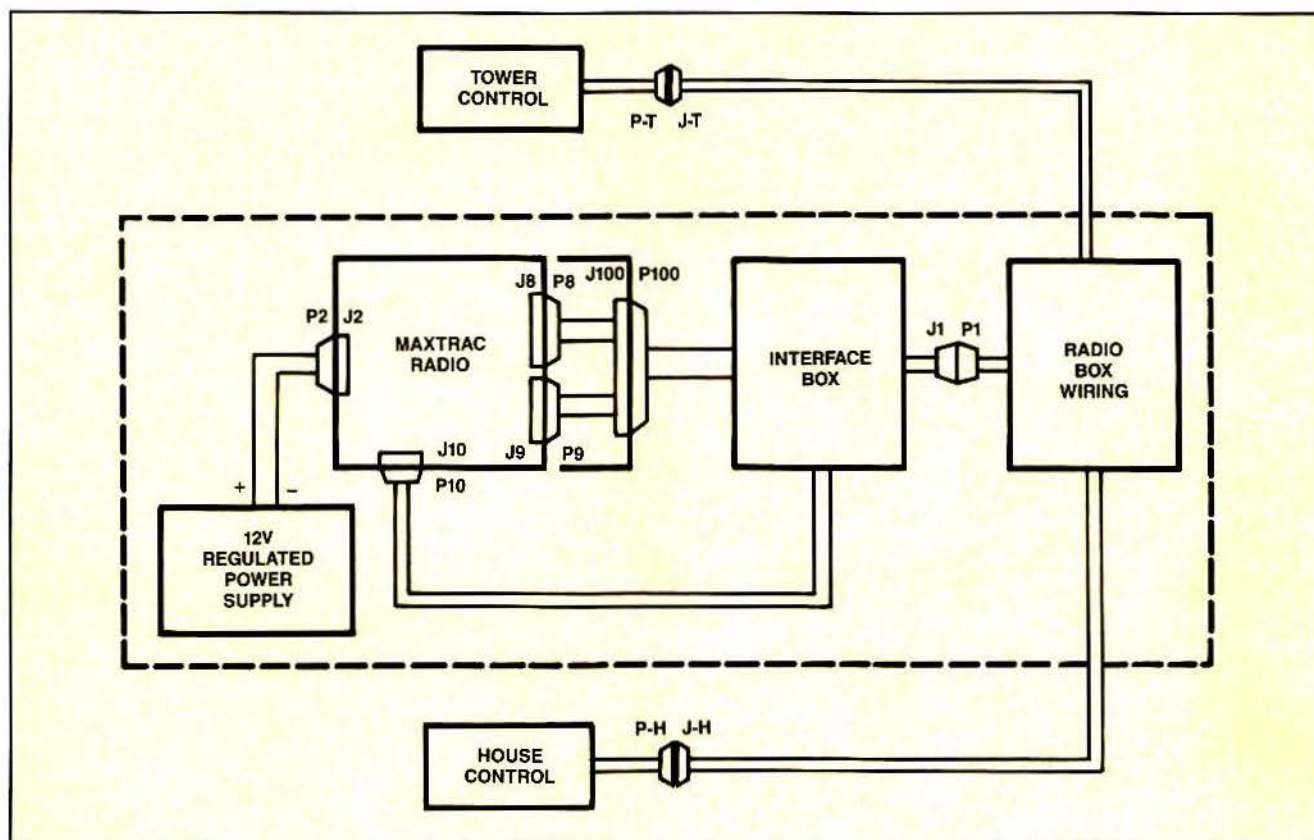


Figure 7. An overall functional block diagram. Individual pieces of equipment shown within the dashed lines are located inside the outdoor radio box. These include the power supply, radio set and interface box. Not shown is a local test speaker located within the outdoor radio box.

low-resistance ground.

An important point about this setup is that absolutely no modifications were made either to the radio set or to the control heads. The control head can be removed from the control box in either the house or tower and reinstalled on the Maxtrac 300, once again making a *standard* Maxtrac 300 radio.

This flexibility is important because

the forestry commission has between 225 and 250 Maxtrac 300 units in its system. The spares carried to serve those units can be used for the tower site base station, as well. When necessary a *standard* board can be replaced without worrying about any modifications to the replacement board.

As of this writing, the *experimental* arrangement has performed well. If it

performs well during the "fire season," it will be considered successful. Then, other sites may be considered for modification.

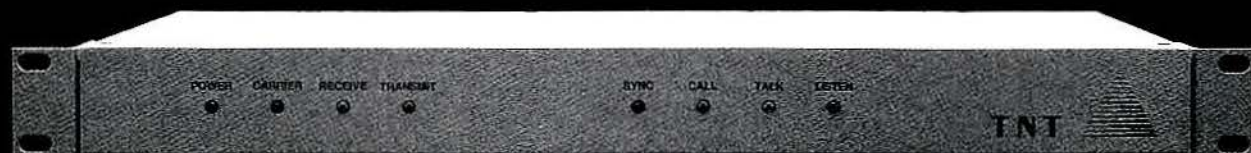
But if more of these control systems are put into service, the old control lines will be replaced with new ones that have more conductors to make all the controls function.



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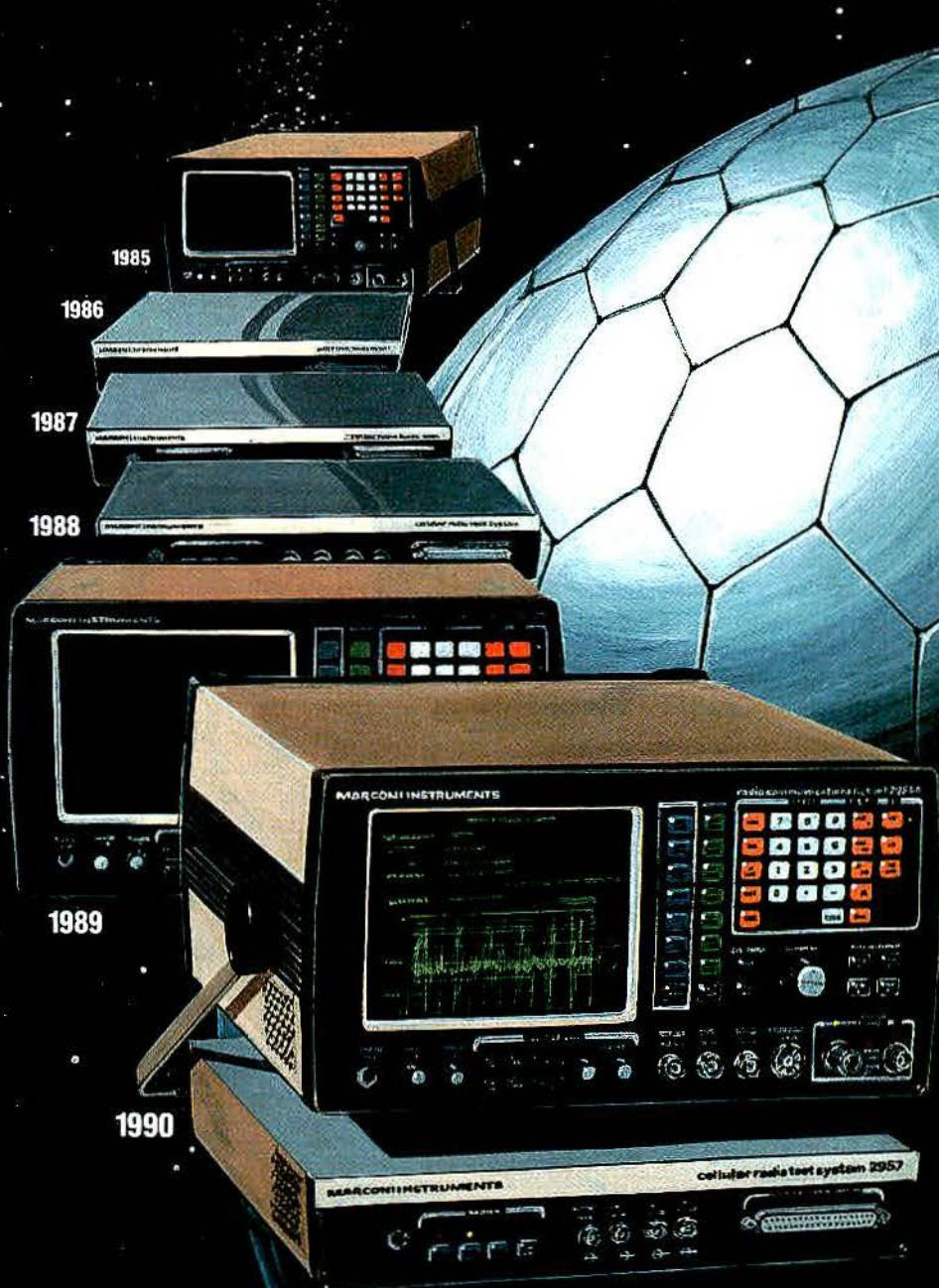
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How to link mobiles to form a repeater

Simple repeater configurations in Alaska support radio communications links as long as 60 miles. Here's how to build a link for use with two Motorola Maxtrac radios. Similar links can be designed for other units.

By Carlton L. Tedrick, P.E.

During a consulting assignment in Alaska, a simple, reliable and effective method of linking two mobile, under-dash transceivers in a back-to-back repeater configuration was needed. Commercially made devices are available to accomplish the task. But because they are designed to be universal, they tend to be complex, and many are difficult to adapt to specific needs. The immediate requirement was for a method

Tedrick, a consulting engineer, owns Communications Service and Engineering, Nacogdoches, TX. He also is an independent contractor with Lockard & White consulting telecommunications engineers, Houston. This information first appeared in Lockard & White's *Network*.

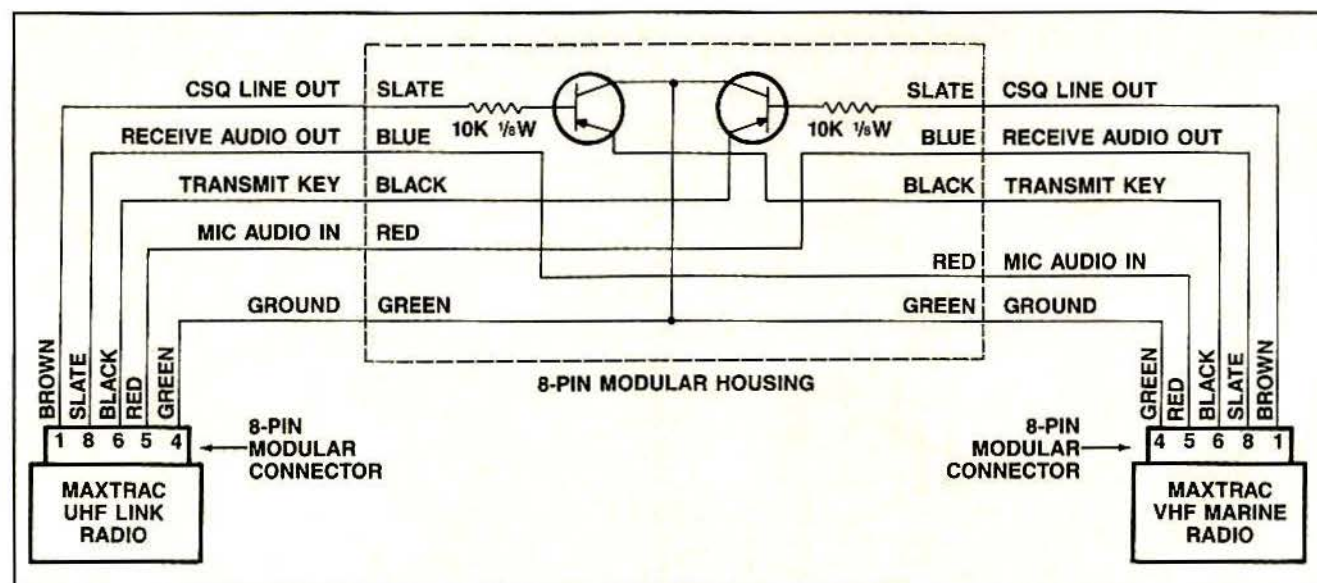
of reusing a number of Motorola Maxtrac mobile units.

The first task was to identify a control point in each receiver that would provide a change of logic state when a signal opened the squelch circuit. Such a point was found at pin 2 of J6 in the Maxtrac. A small jumper was run from that point to the unused pin 1 of J11 on the front panel. This jumper provides a change of state from 4Vdc to 0Vdc when the squelch opens. A small, general purpose transistor completes the transmitter keying circuit.

Locating an adequate point from which to derive received audio to drive the microphone input of the adjacent radio was next. The transmitter's input sensitivity is approximately 80mV rms for 60% carrier deviation. An oscillo-

scope was used to look for suitable fixed audio output points in the receiver. *Fixed* is the key word because any *variable* point, such as the volume control center tap, invites trouble. The signal level at the high side of the volume control was too high, and the handset output produced a level that was much too low. A 1,800 Ω , 1/8W resistor applied between pins 1 and 4 of J8 provided just the right level of audio to feed the microphone input from the handset audio connection of J11.

This audio point is *after* the de-emphasis circuitry, as it should be to drive the microphone input circuitry of the adjacent transmitter. Once the linkup was complete and set up for bench testing, the transmitter deviation was set to produce a "one-to-one" ratio—that is,

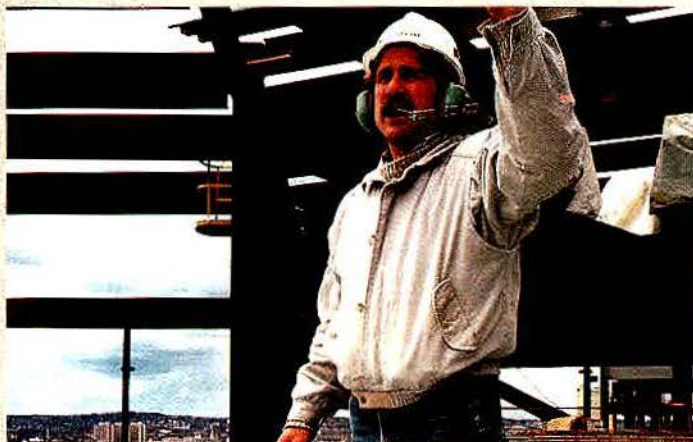


This diagram shows how to wire the double-ended female 8-pin RJ modular connector and the RJ connectors that plug into the Maxtrac radios.

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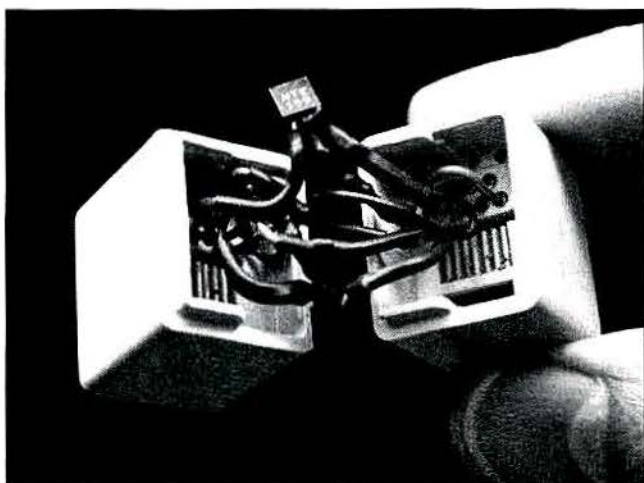
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RJ-type modular connectors are used in the Maxtrac radios, so a double-ended female 8-pin RJ modular connector device was chosen to house the link. This forces compact wiring, and short leads are required in such configurations to reduce the possibility of stray RF pickup.



The double-ended female RJ connector is snapped apart carefully and the two transistors and cross-connections are soldered in place. Heat-shrink tubing was used on each connection because of small working quarters.

a received deviation of 3kHz produced a deviation of 3kHz on the opposite transmitter. Take into consideration continuous-tone controlled squelch system (CTCSS) signaling and its effect on overall deviation settings when making these adjustments.

These modifications were performed on both radios to be used in the linked configuration. They are minimal modifications. Nevertheless, they allow the Maxtrac radios to continue to be used as conventional mobile units, in most instances. These modifications, though, will cause increased handset audio when a handset is used.

Development of a *simple and reliable* "link" device to connect the two radios was necessary. RJ-type modular connectors are used in the Maxtrac radios. A double-ended female 8-pin RJ modular connector device was chosen to house the link. This forces compact wiring, and short leads are required in such configurations to reduce the possibility of stray RF pickup. This type of wiring permits ordinary flat telephone cable and crimp-on RJ connectors to be used, creating a virtually foolproof interconnection arrangement. Remember: *Keep all leads short.*

The double-ended female RJ connector is snapped apart carefully and the two transistors and cross-connections are soldered in place. Heat-shrink tubing was used on each connection because of small working quarters.

All that remains is to build two *extremely short* 8-conductor cables with 8-pin male RJ connectors crimped onto the ends. These cables should be assembled with the connectors in the standard configuration, with locking tabs on all connectors facing in the same direction. This assures proper interconnection and polarity.

With construction complete, bench-testing is in order. Here is where the foolproof nature of the design becomes apparent. You can connect the link device to the radios without regard to orientation or polarity—it should work fine. Remember, though, this particu-

With construction complete, benchwork testing is in order. Here is where the foolproof nature of the design becomes apparent.

lar device is designed to work with *two identical radios* (Maxtracs in this case), and probably will not work with different radios. A similar arrangement probably can be developed for similar radios from other manufacturers.

One minor drawback should be not-

ed. The CSQ line used to control the adjacent transmitter push-to-talk (PTT) is at a logic high when the squelch is closed (no signal received). The CSQ line goes to logic low when the squelch opens (signal received). If one of the radios fails or loses power, the same condition occurs—logic high goes to logic low. This will key the PTT lead of the adjacent transmitter, resulting in an unmodulated carrier on the air.

To prevent this from becoming a problem, the Maxtrac's time-out interval should be programmed for less than three minutes. Then, if one radio fails or loses power, the "dead" carrier will be limited to the timer interval. The transmitter then will shut down until the problem is corrected.

Circuitry to prevent the PTT line from being keyed when one radio fails or loses power can be designed, but it would complicate the link arrangement and would require more extensive modification of the radios. The simplicity of the system as described outweighs the minor drawback.

Several of these linked radio pairs are deployed in Prince William Sound and the Gulf of Alaska at unattended, solar-powered mountaintop sites. They appear to perform as intended. They do not exhibit any sensitivity to nearby RF fields from other radios. This is an inexpensive solution to a unique problem, one that may be useful to others.



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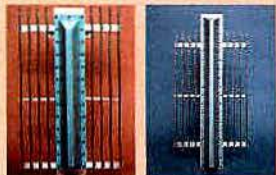
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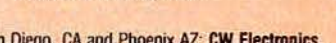
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APCO wrap-up/review

Improved Washington representation and spectrum relief in major cities are top priorities for new APCO president Sam F. Gargaro. Another project seeks to protect the 2GHz microwave band from reallocation.

By Don Bishop and Jane Bryant

The Atlantic Chapter of the Associated Public-Safety Communications Officers (APCO) sponsored the association's 56th Annual Conference in Boston Aug. 26-30. Attendance included 4,736 registered participants.

APCO has its headquarters in New Smyrna Beach, FL.

George W. Murray, the organization's 1989-1990 president, concluded his term during the conference. Each of the other officers advanced a step, with president-elect Sam F. Gargaro becoming president; first vice president Ronnie Rand becoming president-elect; and second vice president John S. Powell becoming first vice president.

APCO members elected Frank Huggins to join the board of officers and the

Major issues facing APCO:

- ☐ Spectrum relief
- ☐ New emergency medical radio service
- ☐ 'Direct access' license applications

line of succession to president. Huggins took his seat as second vice president.

Major issues

Speaking to conference participants, Gargaro defined some major issues facing APCO:

- **Spectrum**—Public safety agencies in major cities continue to request additional radio channels. The new president seeks better representation in Congress and at the FCC in an effort to win more frequencies.

"Take a look at the National Association of Broadcasters," he said. "This group represents people who own the TV and broadcast stations around the country. When they hold their annual convention, sometimes there are a dozen members of Congress in attendance. Why are they at that show and not at this show?"

Gargaro said the broadcasters have the resources and the team in place to get the attention of Congress and the FCC. "It's certainly not a case of Congress understanding their priorities," he explained. "If that were true, you would see a dozen congressmen and senators

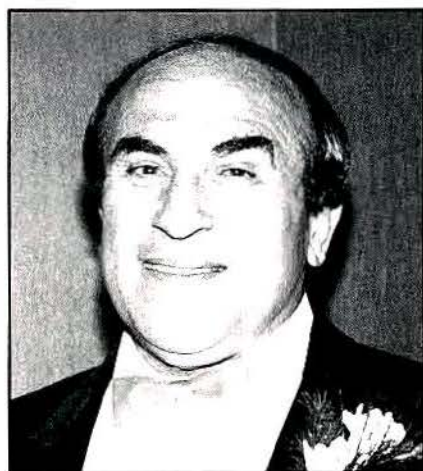
at the APCO conference, talking to people who handle emergency calls, rather than talking to the people who bring you *The Simpsons* and *The Golden Girls*."

He said public safety agencies cannot fight the broadcasters, "but we need to copy their methods. We need a loud voice in Congress. We need to have a plan that tells our story. We need to make the voice of public safety heard in Washington, DC."

Gargaro said the effort should be funded by APCO chapters and commercial interests. "Dispatchers need to realize that more and better training could be made available if we succeed in getting our needs known to Congress. Our commercial members know that a single allocation proceeding at the FCC can result in millions of dollars of equipment being purchased. Our managers and supervisors need to know that the folks in Washington, DC, care about their work and can make their lives easier."

One step toward increased APCO representation in Washington has been taken with a shift in administrative responsibilities from executive director Robert E. Tall to Charles V. Stuckey, who was hired eight months ago as deputy executive director. As a result, Tall is expected to spend more time on legislative and regulatory matters. John Lane, APCO's legal counsel, provides additional representation in Washington. "It is my hope that, a year from now, APCO will have an advocate in Washington; someone who will promote not only APCO's interests, but those of the entire public safety community," the association's new president said.

In addition, Gargaro said a public affairs committee has been formed, with



Sam F. Gargaro: 'Why are [members of Congress] at [the National Association of Broadcasters convention] and not at this show?'

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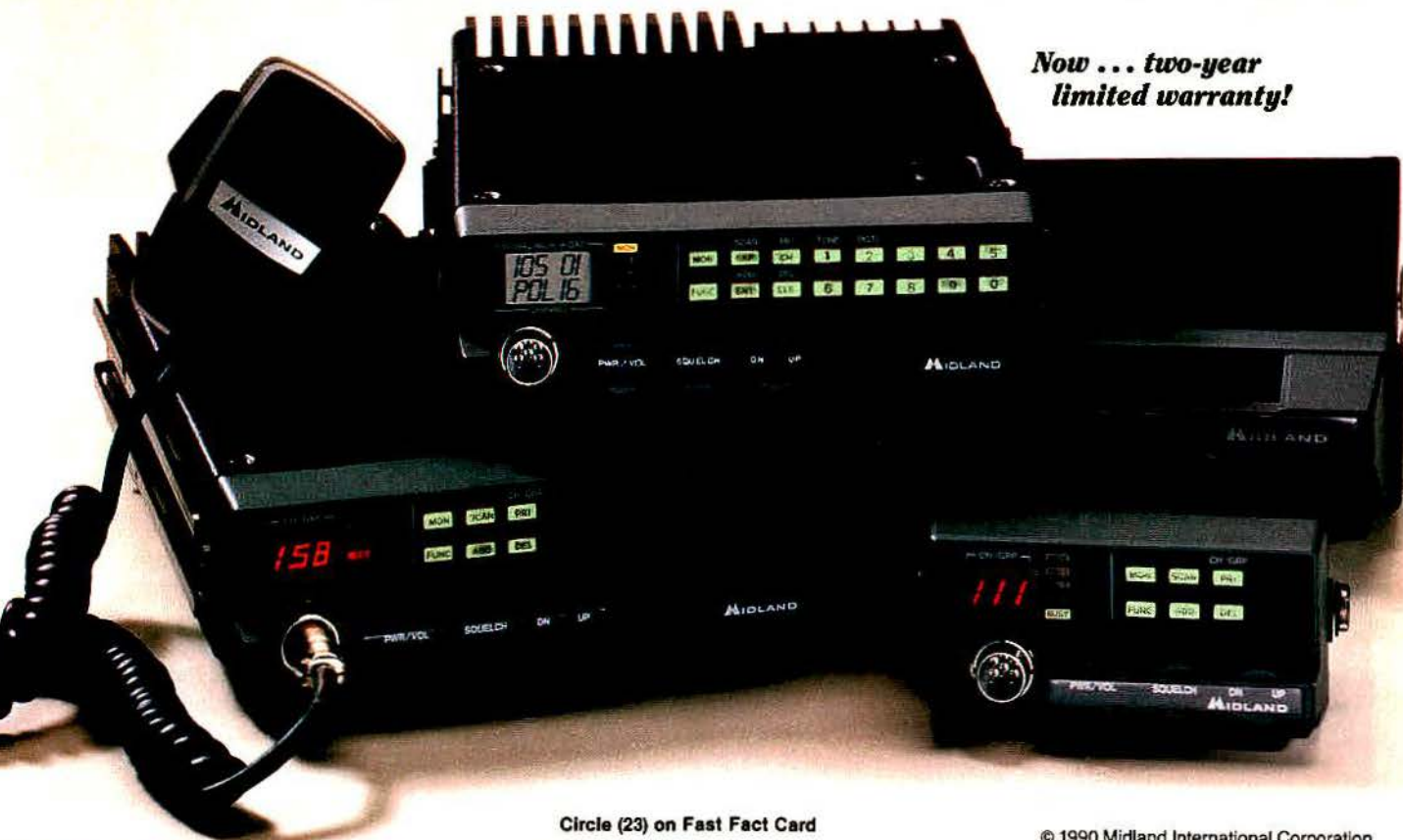
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himself as chairman and Tall as vice chairman. The committee seeks "willing and aggressive people" from each chapter for grassroots support.

• *New radio service*—"We need to see the FCC seriously consider the formation of a new radio service for emergency medical service," Gargaro said.

• *Direct access*—Referring to an FCC proceeding that may provide a way for

license applicants to bypass frequency coordinator approval, Gargaro said: "Everyone should be aware of the dangers involved with this ill-advised proceeding."

Key projects

Several current APCO projects considered especially important to the public safety community include:

• *Project 25*—A joint effort by APCO, the National Association of State Telecommunications Directors (NASTD) and representatives of federal agencies, Project 25's goal is to develop a level of standards of the next generation of digital public safety communications equipment.

Two subcommittees work to develop the standards. One committee focuses on advanced technologies. Among the choices are frequency division multiple access (FDMA), time division multiple access (TDMA) and code division multiple access (CDMA). TDMA seems to have the inside track, with CDMA coming under criticism as deficient for radio services with channels scattered about the spectrum, as is the case with public safety radio services.

The other subcommittee focuses on spectrum resources, and has the task of recommending spectrum choices that may accommodate the technologies named by the other subcommittee.

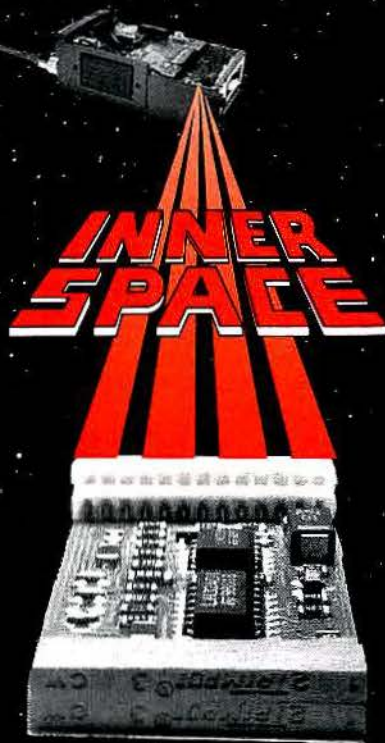


APCO chief engineer Don R. Precure lent a hand in developing a new UHF-TV sharing proposal.

• *Project 26*—Participants in Project 26 have the difficult task of acquiring additional radio spectrum allocations for major metropolitan areas.

Together with APCO chief engineer Don R. Precure, executive director Tall, frequency advisory committee member Vincent Stile and others, project members have developed a proposal for sharing UHF-TV channels that overcomes objections about potential interference

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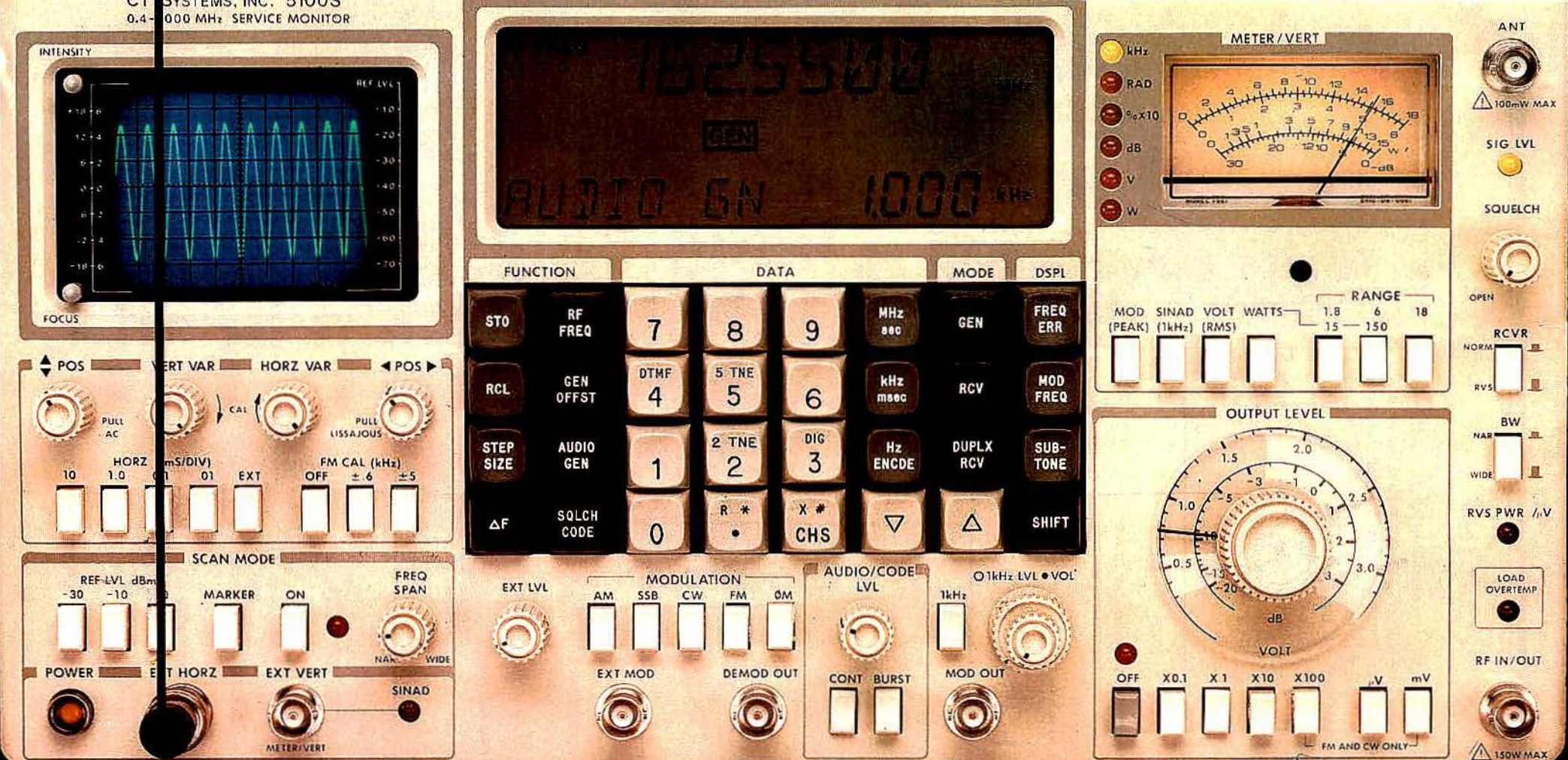
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commonly lodged by broadcasters. The association proposes that communications transmitters that are co-located with TV transmitters and that operate on unused adjacent TV channels be used for "talk-out" frequencies. Co-locating the transmitters maintains a constant, harmless interference ratio throughout the TV station's coverage area.

Speaking to the conference, APCO

first vice president Powell said: "The first targets for spectrum relief include the northeast corridor and Southern California. Vinnie Stile has in his back pocket the first couple of applications to be filed for some new spectrum for some relief in the northeast corridor. Don is working just as hard for other areas of the northeast and Southern California. Then we will address the



John S. Powell: 'The first targets for spectrum relief include the northeast corridor and Southern California.'

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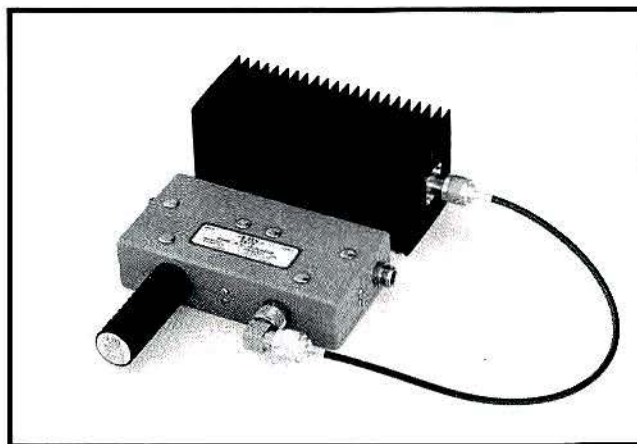
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other areas of the country with respect to need."

Certain already shared non-adjacent UHF-TV channels in the channel 15-to-channel 20 range would be converted to "talk-in" frequencies and paired with the new "talk-out" frequencies.

Although the plan appears to satisfy existing interference limits, all land mobile sharing of UHF-TV channels has been placed on hold in recent years as the FCC reserves UHF-TV spectrum for possible high-definition TV broadcasting. APCO secured an amendment to the Communications Act that places a certain priority for the FCC to satisfy public safety radio spectrum requirements. The congressional mandate may allow APCO to succeed in moving its UHF-TV sharing proposal forward where business and industrial radio service efforts to share additional UHF-TV channels have seen no action.

• *Project 27*—Developing new books and publications to be distributed through APCO comes under Project 27.

President-elect Rand told the conference that APCO's effort to "professionalize" the public safety communications industry is closely tied to education.

He said one new program for 1991 is a 40-hour telecommunicator course. "We have had the 80-hour for some time now and it has been well received. But many people have difficulty getting ap-

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Key APCO projects include:

- ☐ **Project 25**—To develop digital standards.
- ☐ **Project 26**—To acquire additional radio spectrum for major metropolitan areas.
- ☐ **Project 27**—To develop new books and publications.
- ☐ **Project 28**—To defend the 2GHz point-to-point microwave band.
- ☐ **Project 32**—To develop a method for filing license applications electronically.

proved by their agencies for the two-week course." The 40-hour course is a condensed version, basic-level course. "We are in the development stage on an advanced course that could be administered later, in a two-or-three day course, for medical, law enforcement and fire agency employees."

Other courses are under development

for emergency medical, fire and law enforcement agency employees.

"One book I would like to mention in particular," Rand said, "is J. Rhett McMillian Jr.'s book, *The Primer of Public Safety Telecommunication Systems*."

"We have a video about managing stress by Wendy Schofield."

The final goal for the APCO Institute, under which many of the educational projects are established, "is for it to become a college, a university without walls, so to speak, so we can have our membership take their training at the local university or local community college and take some by correspondence and take some of our courses to pick up credit hours," Rand said. "We want to become a place where we can assemble those, as well as fee some of them, and in fact grant a degree probably at the associate level and eventually at the bachelor's and above so we can in fact 'professionalize' this industry."

• **Project 28**—A joint effort by APCO and NASTD, Project 28's purpose is to defend state and local government agencies' use of the 2GHz point-to-point microwave communications band. Committee co-chairman Murray said the project centers on helping to develop the U.S. diplomatic position for the 1992 World Administrative Radio Conference.

Murray said countries in other

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Mobile Communications

regions seek to change the allocation from fixed and mobile services to mobile services only. If such a reallocation were adopted and the U.S. consents, present 2GHz public safety backbone microwave systems would be rendered obsolete. They would have to be replaced with new systems on other frequencies, a requirement that poses massive technical challenges and costs.

"Wave goodbye to 2GHz fixed microwave if you don't get off your cans," Murray told the conference. "I'm serious. You're going to have to buy new microwave systems if this goes the way it looks as though it may."

The project committee had mailed questionnaires to APCO members to develop a record of the microwave band's occupancy and use. "Send it back to us so we can use it as ammunition to fight the battle," Murray said. "I promise you that APCO and NASTD are going fight the battle. We are going just as far down the road as we can to keep the 2GHz systems in place or to find a suitable replacement cost-free. Let's face it, if we



George W. Murray: "Wave goodbye to 2GHz microwave if you don't get off your cans."

cannot pay our salaries—and many of us are in that position today—we sure as heck can't buy new microwave systems."

• **Project 32**—APCO's project to develop a method for filing license appli-

cations electronically with the FCC has three phases, first vice president Powell explained. "Phase 1 was a trial phase. We agreed at a meeting with the FCC in mid-July that we had successfully proven the concept was viable through some testing we conducted back and forth with our contractor, CET. I've got to give CET a lot of credit. They put in some tremendous hours and some tremendous work on the part of their programmers and the commission to prove that this was a viable method of licensing," he said.

The project now is in Phase 2, which includes testing with sending live data into the commission's database. After some trial applications were sent back and forth, APCO sent its first error-free application electronically in mid-August. "That means no paper," Powell said. "We have worked out the details of how we handle signatures and attachments and we are moving ahead rapidly."

Powell said APCO is raising its frequency coordination fees. "CET [AP-

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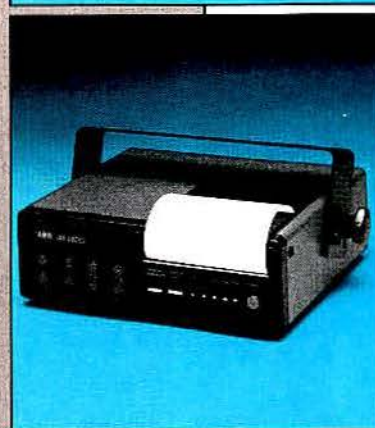
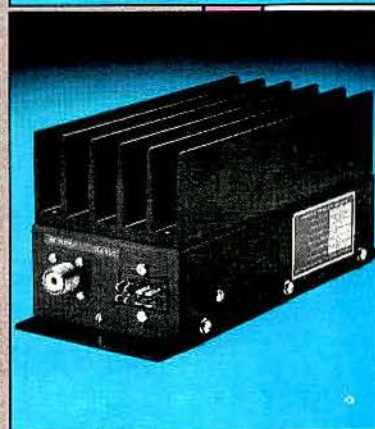
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CO's frequency coordination service contractor] has not raised rates since the 1986 contract," he said. "We have cost-of-living raises we have to give to our employees. The benefits costs to our employees has been increasing."

Coordination rate increase

He said APCO has approved a 5% increase in frequency coordination fees, rounded to the nearest \$5. The new-frequency fee remains unchanged.

The new "APCO Enter" program that Powell said was developed with the assistance of the association's staff programmer had to be expanded to a greater number of data elements. "Originally, we only entered the first 25 elements of form 574," he explained. "Now, with Project 32, we have to enter virtually all of it to file it electronically."

Educational sessions

The conference offered an extensive schedule of educational sessions. Highlights from two of the sessions include:



Joe Galleli: 'A trend in mobile data is away from analog and toward digital environment.'

Mobile data—According to session speaker Joe Galleli of Ram Mobile Data, New York, mobile data communication has been available to public safety communications users since 1972.

His talk, "Mobitex: The Mobitex-Based Public Safety Mobile Data Solu-

tion," explained the makeup of Ram's mobile data network:

Ram operates a mobile data network.

Mobitex is the system the network uses.

Thus, Ram is a network, not a system. Ram's network control center is in Woodbridge, NJ.

The name "Mobitex" is a contraction of the phrase "mobile text." Mobitex is a packet network that originated in Sweden. Sweden, Norway, Finland, Canada and the United States have Mobitex systems, and the United Kingdom will have the system in 1991, he said. "By 1992, the United States will have more than 500 base stations, but that number may grow to 1,000 in the not-to-distant future," he said.

"A trend in mobile data is away from analog and toward digital environment," Galleli said. The Mobitex system uses low-power transmitters and reuses frequencies in a given area. The network carries only data, offers message security and includes mailboxes and group messages.

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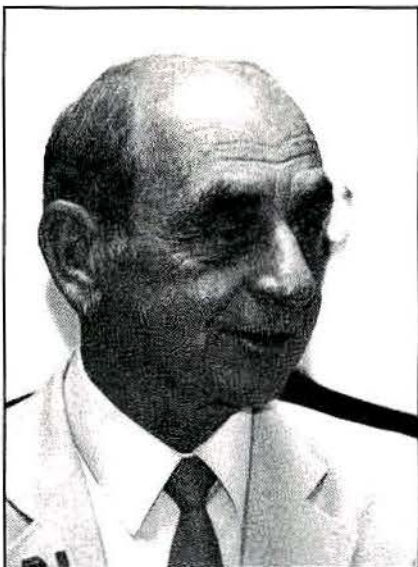
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Art McDole, retired director of communications for Monterey County, CA, received APCO's Rhett McMillian Award.

The packet switched system, he explained, has five levels of hierarchy:

- mobile level or terminal level

- base station level
- local switch
- regional level
- national level

The system is redundant and operates at 8,000 bits per second, he said.

Trunked radio—Putting together a trunked radio system involves much preparation and execution, according to panelists at the "Considerations for Acquiring a Trunked Radio System" session.

Trunking considerations include formal planning and consultation with vendors and others. Site preparation, computer software and three-dimensional propagation path charts are fundamental tools in developing trunking systems, according to panelist Eric Broviak of Geuga County, OH. (See "Use Digitized Terrain Data To Plan a Repeater Site," August 1989 *MRT*, for more information on computer software and three-dimensional path profiles.)

The use of consultants was contrasted by Frederick G. Griffin of Lynchburg, VA. Griffin explained that some

companies can draw on internal expertise while others may need the help of outside resources in considering all phases and angles of developing and implementing a trunked system project. He explained: "Trunk radio requires a multidiscipline business approach."

Awards

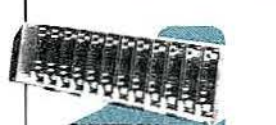
Art McDole, retired director of communications for Monterey County, CA, received APCO's Rhett McMillian Award in recognition of his efforts to promote APCO and public safety. He was presented with a plaque and a commemoration scrapbook at APCO's closing banquet. McDole serves as an editorial advisory board member for *MRT*.

Next year's APCO conference will be Aug. 11-15 in Tulsa, OK. Information about the conference is available from APCO at P.O. Box 669, New Smyrna Beach, FL 32170-0699; 904-427-3461.



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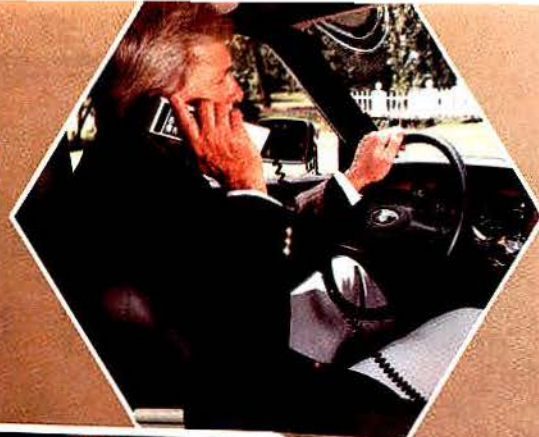


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Specialized mobile radio makes ready for the 1990s

High-power, single-site analog SMR systems may give way to multisite, low-power digital 'ESMR' systems. The coexistence of SMR and ESMR systems and ESMR population coverage are issues yet to be settled.

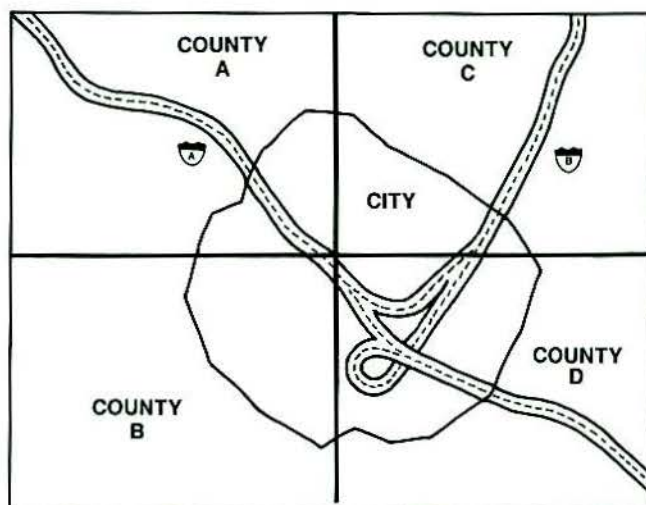


Figure 1. This example shows a city within a four-county metropolitan statistical area (MSA), a designation used by cellular carriers to define a system location.

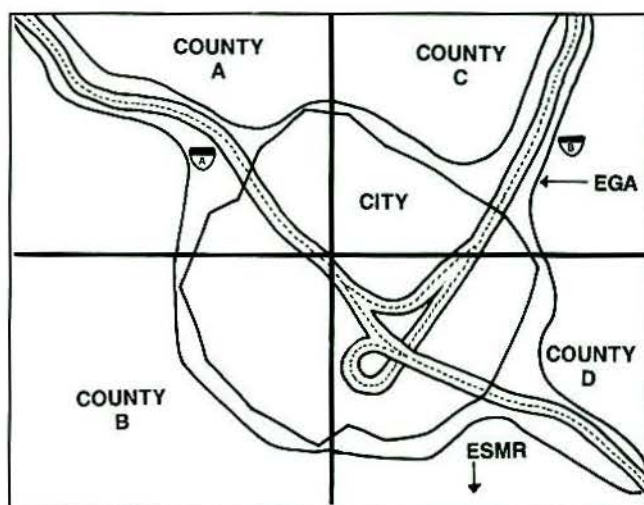


Figure 2. For enhanced specialized mobile radio, the example four-county area is an 'ESMR.' The area covered by an ESMR system is an 'enhanced geographic area' (EGA).

By Robert C. Shapiro, P.E.

The specialized mobile radio (SMR) industry is poised for major changes. Two FCC rule waiver requests that have been granted and a third that is pending offer methods for improving 800MHz and 900MHz spectrum use to an optimum level.

New York-based Ram Mobile Data and Millicom were granted waiver requests and have started to build nationwide 900MHz trunked systems designed for data communications. The FCC allowed Ram to take what normally is a

10-channel block of 12.5kHz-spaced channels at one site and split them for use at more than one site.

With what is in some ways an even more ambitious proposal, Fleet Call, Bloomfield, NJ, has applied for a waiver involving its currently licensed 800MHz SMR channels in six metropolitan areas: Los Angeles, San Francisco, Dallas, Houston, Chicago and New York. The waiver application requests authority to implement a new approach to trunked two-way mobile radio using a digital format.

After Fleet Call filed its application in April, many entities, including manufacturers, other SMR system operators, cellular telephone system operators, trade associations and FCC-designated frequency coordinators for various radio services, filed comments and asked

Fleet Call to clarify some aspects of its request. Responding, Fleet Call revised its waiver request in June. FCC action on the revised application is pending.

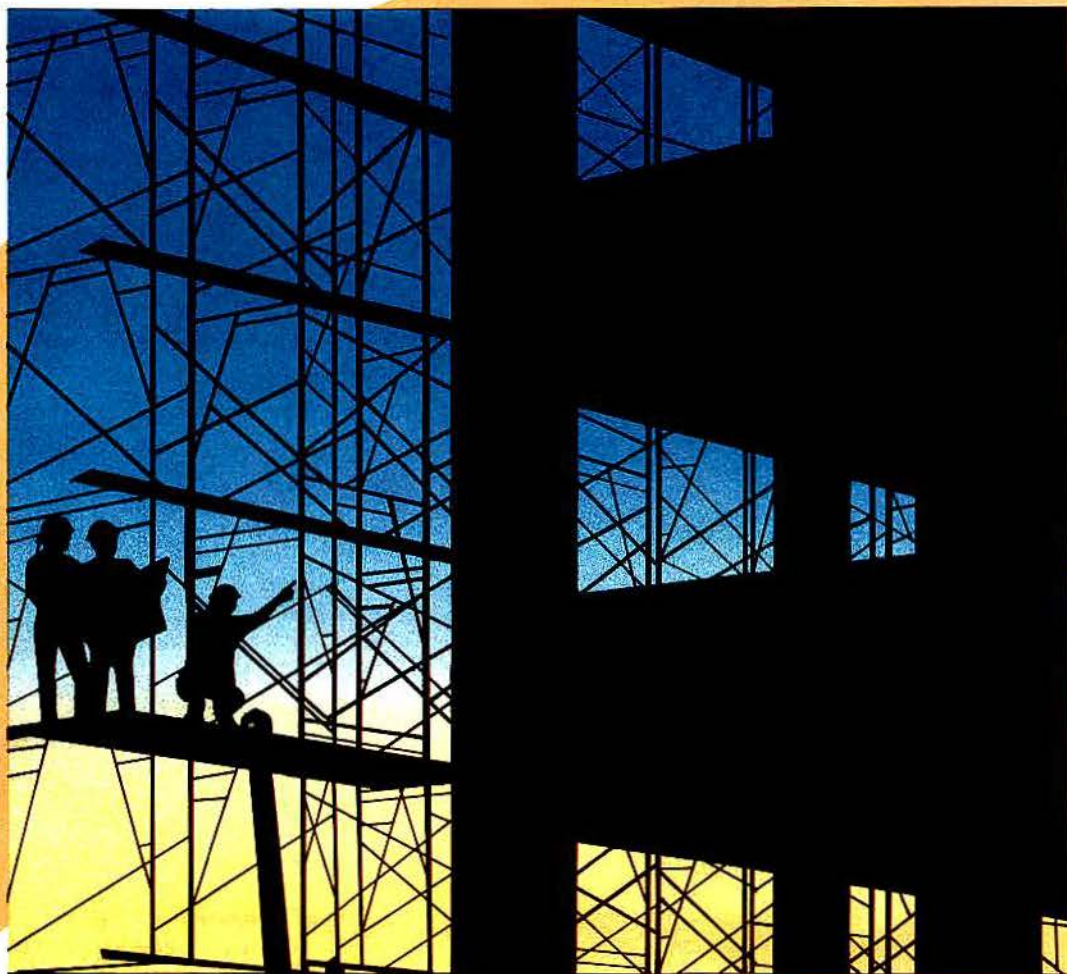
Buzzwords

The buzzwords for this new approach are "enhanced specialized mobile radio" (ESMR) and "enhanced geographic area" (EGA).

The FCC licenses cellular mobile telephone carriers to place transmitters at various locations within their metropolitan statistical areas (MSAs). Fleet Call seeks similar permission to place transmitters at various locations within ESMRs.

Cellular carriers may use the same frequencies at different sites within an MSA, provided the frequency reuse arrangement does not cause interference

Shapiro is a systems engineer with Decibel Products, Dallas. He is a member of the technical committee of the American SMR Network Association.



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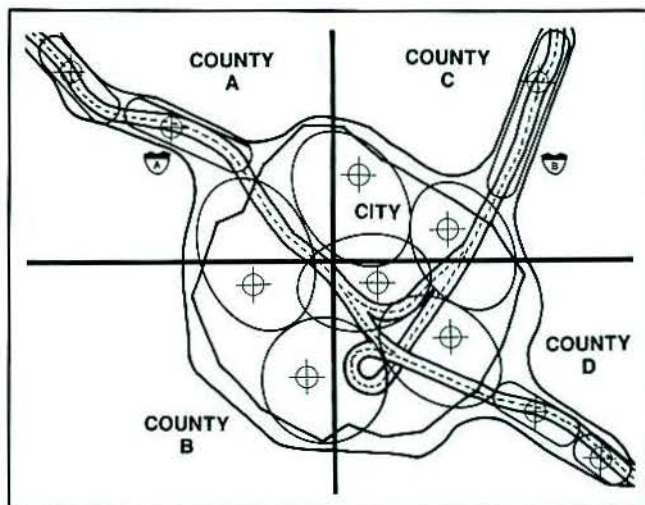


Figure 3. The EGA is served by microcells, a term for multiple low-power, low-antenna ESMR transmitter sites. Frequencies in one cell may be reused at a distant cell.

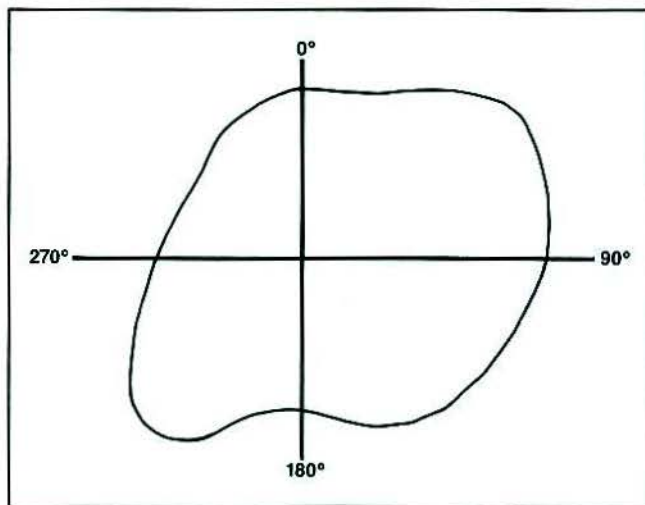


Figure 4. The Carey contour's smooth shape results from predicting coverage along only eight radials. A 39dB μ Carey contour may be used for interference predictions.

within their own system or to other systems. Fleet Call seeks similar frequency reuse for its ESMR systems.

Frequency reuse multiplies the number of users who may operate radios in the same ESMR at the same time.

Time division multiple access (TDMA) digital modulation multiplies the number of users who may operate simultaneously on the same channel. The use of low-power transmitters and TDMA modulation helps to prevent interference to other systems and within the ESMR system. But TDMA two-way radios are not compatible with analog radios presently in use.

Figure 1 on page 42 shows an example of a four-county MSA that contains a major city. Figure 2 on page 42 shows the outline of an EGA that embraces the city and interstate highways that carry traffic to and from the MSA. Such an EGA resembles a cellular carrier's cellular geographic service area (CGSA) as defined in Part 22 of the FCC rules.

The EGA defines an interference-free operational area where ESMR base station transmitters do not deliver interference to mobile units on frequencies assigned to other SMR systems or ESMR systems.

The EGA consists of frequencies in coverage cells. The same frequencies might be used by more than one cell. Figure 3 above shows that an ESMR might use a number of cells to cover the EGA.

Certain techniques are required to de-

fine the areas within the ESMR (remember, ESMR is a parallel term to the cellular MSA) and the EGA (cellular parallel: CGSA).

The ESMR might be calculated using MSA or population data, similar to the way it is done in the cellular industry. Such a calculation allows for an optimum use of frequencies in a heavily populated area.

The Carey method could be used to

The purpose of defining the EGA is to identify base station locations within an interference-free zone.

define a 39dB μ coverage contour for the EGA, based on proposed and actual transmitter sites, transmitter powers and antenna heights. (See Figure 4 above.) The Carey method was developed in the 1950s to describe the coverage areas for improved mobile telephone service (IMTS) under Part 22 rules. The coverage contours are calculated using tables based on the 150MHz band and modified for use with 800MHz and 900MHz

frequencies. The contours generally are drawn on U.S. Geological Survey topographical maps.

Creative antenna system configurations using side-mounted antennas and offset patterns allow coverage to be shaped to avoid interference among systems and cells. But the contours do not show how frequency reuse should be implemented.

The purpose of defining the EGA is to identify base station locations within an interference-free zone. Using census data and the EGA, the percentage of ESMR population covered by the EGA can be calculated. The EGA establishes a precedent for site propagation coverage and transmitter effective radiated power (ERP) levels.

Design tools

Once the ESMR is identified and the EGA is established, frequencies are allocated to allow reuse with the greatest efficiency. Propagation analyses and a proper antenna system design help to establish the reuse pattern.

Propagation analyses usually are made with a computer model. They reveal coverage patterns that are close to what actually may be expected from the operating system. They help to establish whether any two sites using the same frequency would have overlapping coverage, which is to be avoided.

Directional antennas and the side-mounting of omnidirectional antennas may help to create interference-free sys-

tems. Low-loss combiners and efficient, multiple-signal amplifiers (class A or AB) allow the maximum allowable signal to be broadcast through the antenna system.

FCC rules require 70 miles to separate co-channel SMR transmitter sites in most parts of the country, 105 miles in a few areas, including Southern California. To protect ESMR systems, Fleet Call asks that new and existing high-power (1,000W ERP) SMR systems be restricted from moving existing transmitter sites and placing new high-power transmitter sites close enough to an EGA to cause interference. Existing trunked systems adjacent to the new ESMR may have to reduce ERP to be compatible with the new co-channel digital radios.

Interference that may be delivered to an ESMR channel could affect more than one user because, with the use of TDMA, each channel has the potential to carry four or more voice circuits.

Because proposed ESMR base station power would be limited, the request specifies that they could be placed as close as 48 miles to co-channel SMR or ESMR base stations. ESMR base station ERP is specified at 100W, instead of 1,000W, because the use of multiple sites reduces the distance between the mobile unit and the base station even at the boundaries of the EGA.

The ESMR proposal pending before the FCC specifies how an ESMR and an EGA should be defined technically, but it does not mention 39dB μ contours. The 39dB μ signal level is the guideline for reducing interference between co-channel users. It is required for cellular system designs and might be required for the new ESMR systems.

Among the questions to be answered as ESMR technology evolves are:

- Is the 39dB μ contour an accurate measure of interference?
- Will the FCC allow cellular-type system designs to be used under Part 90 private radio rules?
- How are EGAs going to be defined?
- How will the population to be served by the system and its coverage area be defined?

The answers will allow all radio communications industry participants to benefit from the results of ESMR development.



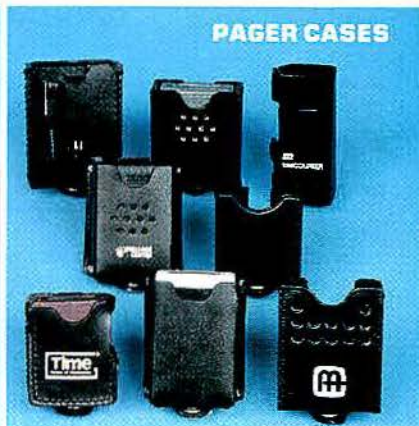
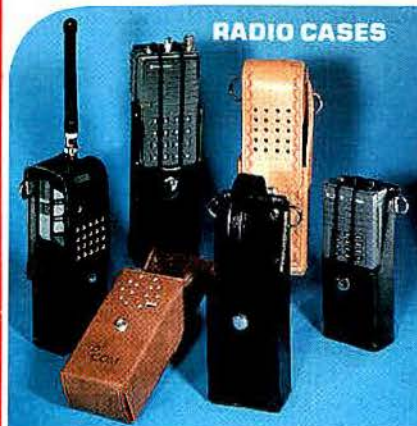
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Digitally coded squelch: What makes it work—or fail

Part 1—Digitally coded squelch systems are widely used, but many technicians do not know how they function. Understanding codeword construction helps to unravel some of the mysteries.

By Mark Nadir

Squelch circuits mute radio receivers until they receive an RF signal, thus preventing the operator from having to hear background noise.

Coded squelch also blocks unwanted signals. When used on a shared channel, coded squelch relieves the operator of having to listen to other companies' or agencies' communications while awaiting a message intended for him.

Community repeaters use coded squelch to separate user groups and to prevent noise and intermodulation interference from being rebroadcast.

Continuous-tone coded squelch

Nadir specializes in the design of digital radio communication systems. He is president of Globestar Technology, Ft. Lauderdale, FL. (Telephone 305-763-1569.)

(CTCSS) uses audio frequencies below 300Hz. A single tone is assigned to each user or group of users. A decoding device in a radio switches on its speaker when the proper tone is received. Filters in the audio amplifier attenuate the tone to make it less noticeable to the user. Because the tones are below the 300Hz-to-3,000Hz audio speech band, they are referred to as subaudible, even though they are within the range of human hearing.

Examples of commercial CTCSS are the Ericsson-GE Channel Guard and the Motorola Private Line squelch.

Digitally coded squelch (DCS) uses subaudible frequencies, too, but there are more differences than similarities between DCS and CTCSS. Neither system is particularly simple, as evidenced by the number of revisions that vendors have made to DCS and CTCSS products. Field modifications, product

recalls, dissatisfied customers and downgraded performance specifications dot the record of squelch system manufacturing. Getting the software right is the least complicated aspect of product design.

With CTCSS, a single, low-level subaudible tone is superimposed continuously with the voice on the FM carrier. The Electronic Industries Association has listed 37 tone frequencies in its CTCSS standard. Some manufacturers have added one or more tones to the list; others use continuously variable tone generators to allow any frequency within the subaudible range to be used. In any case, the number of usable codes is limited by the capacity of decoders to differentiate between them. Commonly, only about half of the EIA tones may be used on the same channel. The EIA divides its list into two groups as an aid to code selection.

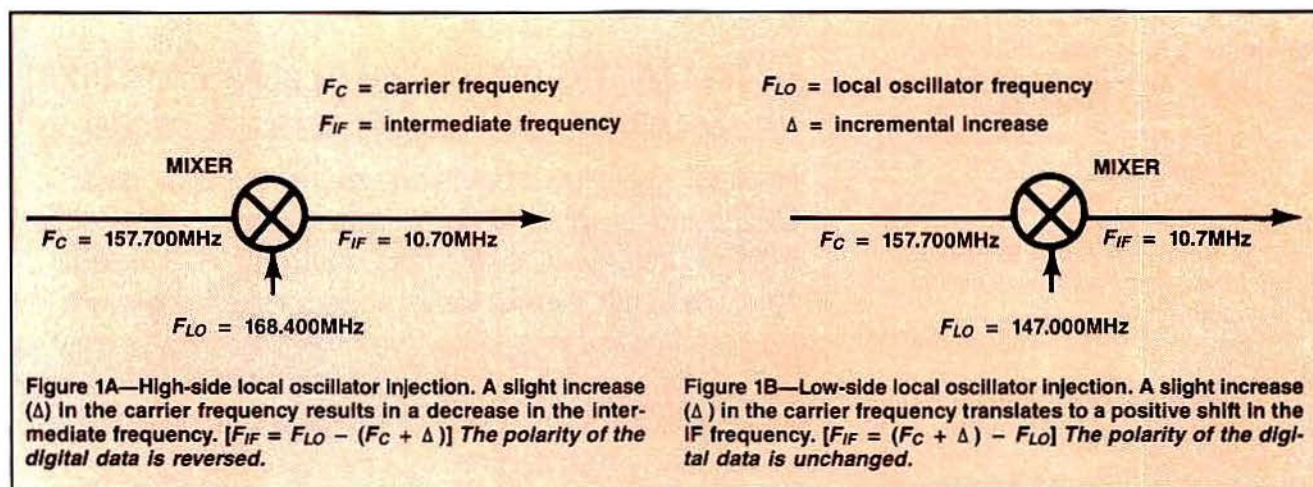
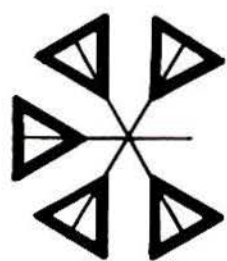


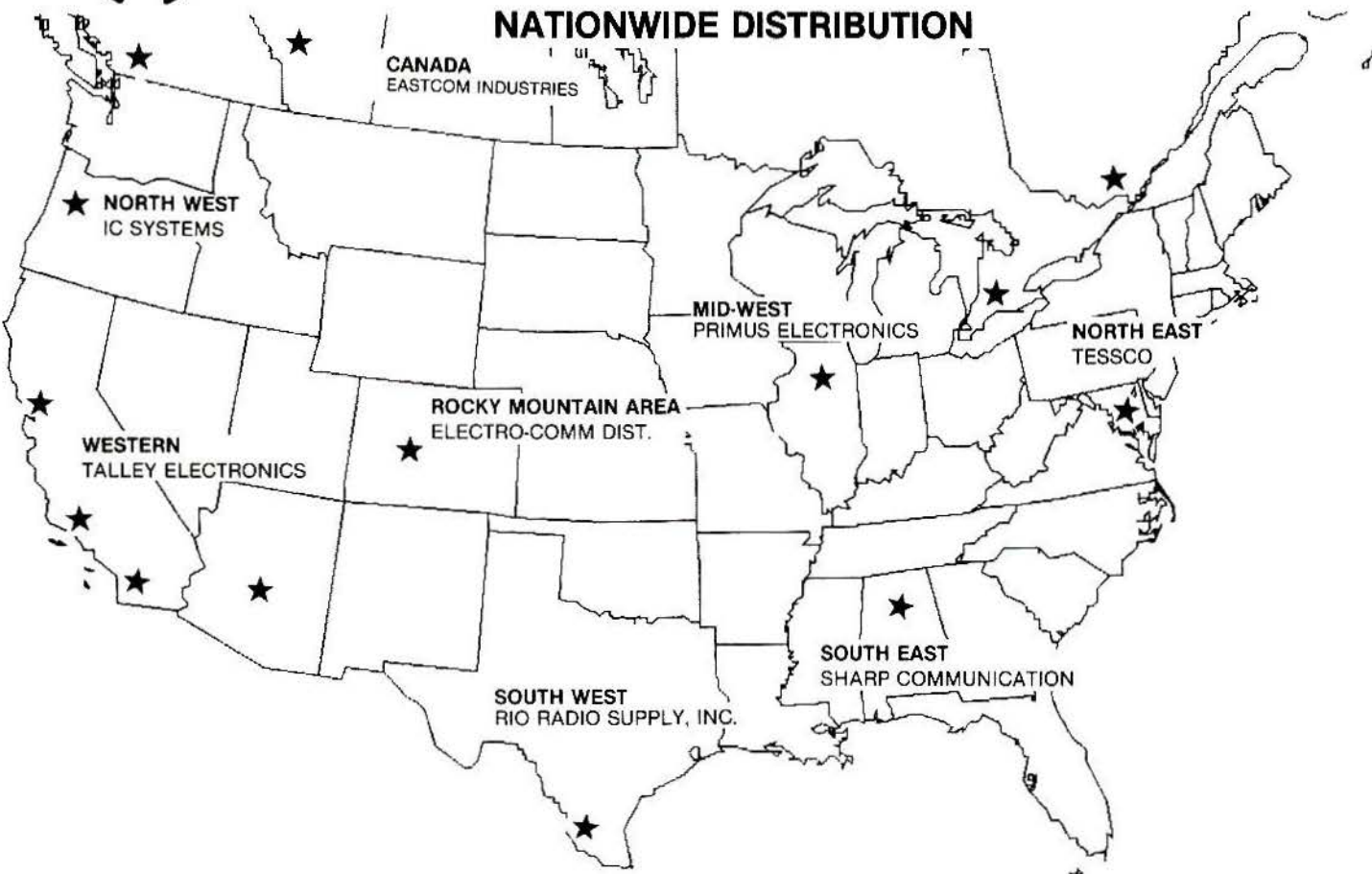
Figure 1. This arbitrary diagram of the first mixer of a hypothetical VHF radio receiver with a first IF of 10.7MHz shows how high-side local oscillator injection reverses DCS signal polarity. Low-side injection leaves the DCS signal polarity unchanged. Thus, receiver and DCS circuit designs are closely related.



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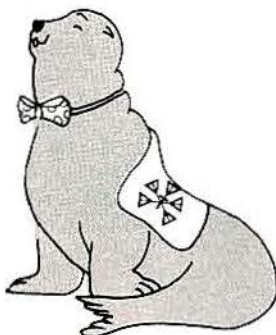
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In contrast, DCS uses a 23-bit digital "word" with a capacity of 83 codewords. All may be used on the same channel.

The codeword repeats cyclically every 171ms and concludes with a 180ms burst of turn-off code—a 134Hz tone. Because the signaling format is digital, the bandwidth the DCS signal occupies is substantially greater than that required for CTCSS. In fact, "DCS" might just as well stand for "direct current squelch" because the occupied spectrum includes frequency components beginning at dc.

Conventions

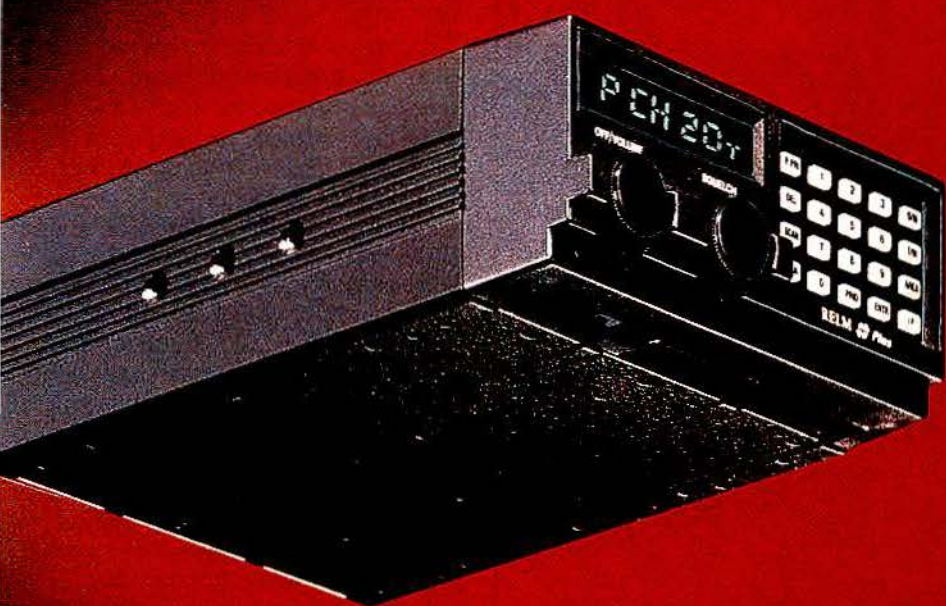
The use of binary signaling requires the DCS codeword's encoded 1s and 0s to be converted into an analog signal to modulate the FM carrier continuously. To implement the conversion, a convention regarding the binary DCS format has been developed.

...there is a 'polarity' associated with digital squelch signals.

The filtered binary waveform directly modulates the FM carrier such that a binary 1 corresponds to a positive carrier frequency shift relative to the unmodulated carrier. Similarly, a binary 0 corresponds to a negative carrier frequency shift.

These positive and negative carrier shifts imply that there is a "polarity" associated with digital squelch signals—and that is the case. In fact, this convention brings the entire design of the transmitter and receiver into scrutiny, something unheard of in the design of tone squelch (CTCSS) systems.

Figure 1 on page 46 is an arbitrary diagram of the first mixer of a hypothetical VHF radio receiver with a first intermediate frequency (IF) of 10.7MHz. The proposed receiver is tuned to 157.70MHz using either high-side local



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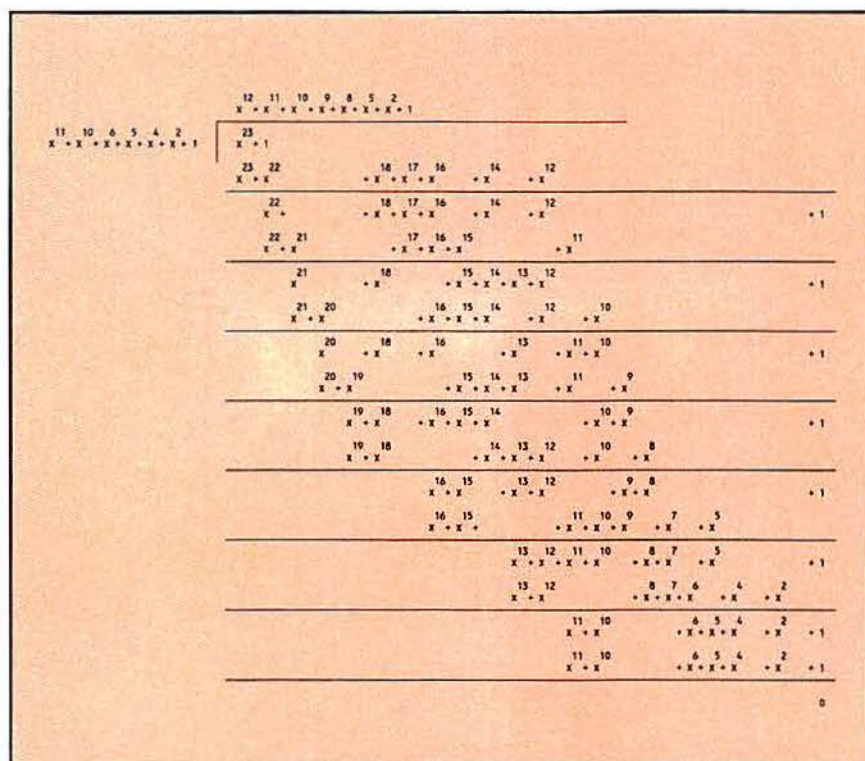


Figure 2. Modulo-2-arithmetic long division may be used to calculate Golay codes.

oscillator (LO) injection (see Figure 1A) or low-side LO injection (see Figure 1B).

For high-side injection, a positive incremental carrier shift results in a negative shift at the mixer output. Thus, by using high-side injection anywhere in the receiver, the polarity of the DCS signal is inverted by the mixer and the established convention is violated.

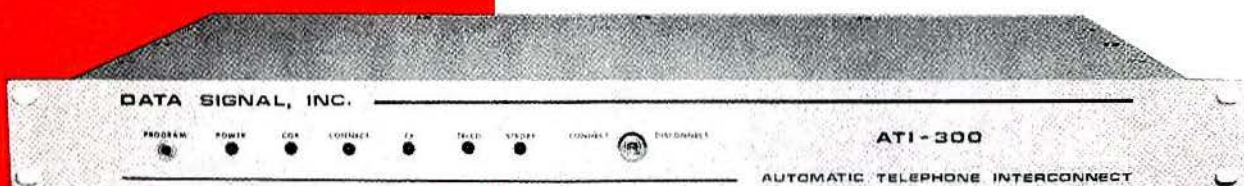
The polarity convention is important because 41 of the DCS codewords are binary inverses of another 41. Thus, those radios that flip the receiver second LO injection to avoid spurious responses must provide a method to invert the DCS signal polarity.

All digital squelch decoders include some method to logically invert the received DCS signal polarity. Typically, the method takes the form of a jumper on the DCS encoder-decoder.

Such an arrangement works fine with most radios. But care must be taken with some of the wideband radios now coming into production. These radios may flip the second injection oscillator

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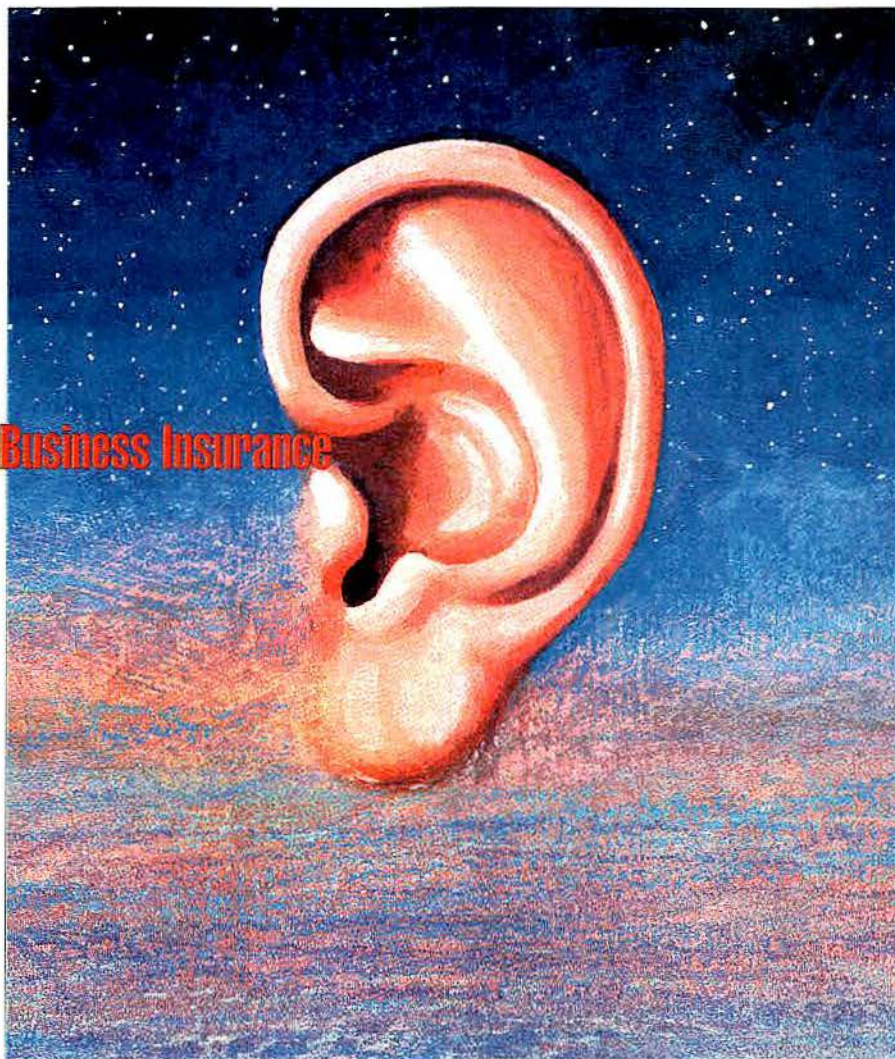


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dynamically and automatically as they are tuned to different receive channels. If so, they require equivalent adaptability from the DCS decoder logic.

Along similar lines, certain transmitter modulator designs may require the capability to invert the encoded DCS signal.

Codeword structure

Digital squelch uses a 23-bit codeword transmitted at 134bps to implement a subaudible signaling system. The number 23 has special significance.

In about 1955, M.J.E. Golay concluded his search for "perfect" codes with the construction of the code that bears his name. The Golay code is "perfect" in that it is capable of detecting and correcting *any* combination of three or fewer errors found in the codeword.

...the Golay code is one of only two known perfect binary codes...

The Golay code is one of only two known perfect binary codes having this capability over their code fields. (The other is the Hamming code.) Despite this capability, most DCS decoders do not use the error-correction feature. Instead, they rely upon the minimum distance between adjacent codes, which is a property of the Golay code set.

The distance between any two codewords is the number of bits that are different. Consequently, the minimum distance for the code set is a measure of how different each codeword is from every other codeword. For the Golay code, the minimum distance is 7 bits. Restated, seven or more errors must occur before a given codeword could be decoded, erroneously, as another.

The Golay code is known as the (23,12) binary code because it is 23 bits

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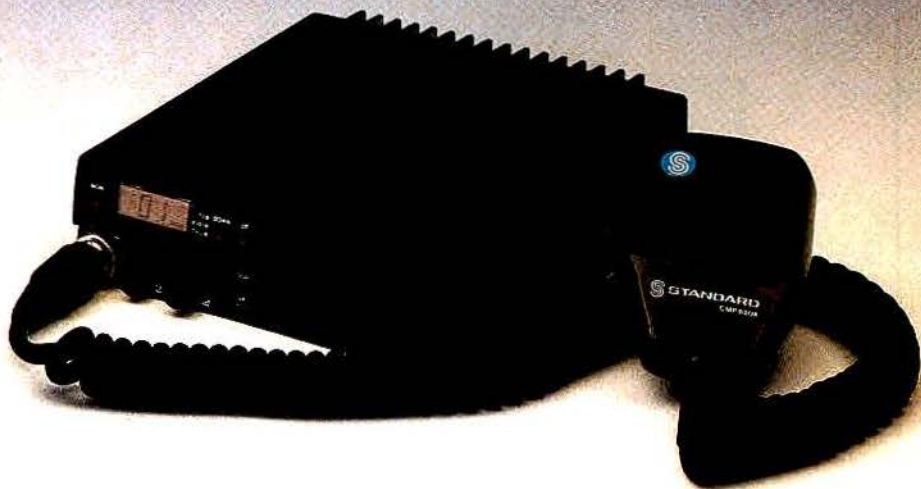
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long and it contains 12 bits of data. The remaining 11 bits are the parity check-bits that provide redundancy and guarantee the distance between codewords.

The Golay code is a cyclic code. A cyclic code has a property such that shifting a codeword cyclically produces another codeword. This is a useful fea-

ture because shift registers can be used for encoding and decoding purposes.

Linear binary codes are characterized by a generator polynomial that is completely adequate to create the codeword from the data field. There are two equivalent generator polynomials for the Golay code. They are:

$$g(X) = 1 + X^2 + X^4 + X^5 + X^6 + X^{10} + X^{11}$$

or

$$g(X) = 1 + X + X^5 + X^6 + X^7 + X^9 + X^{11}$$

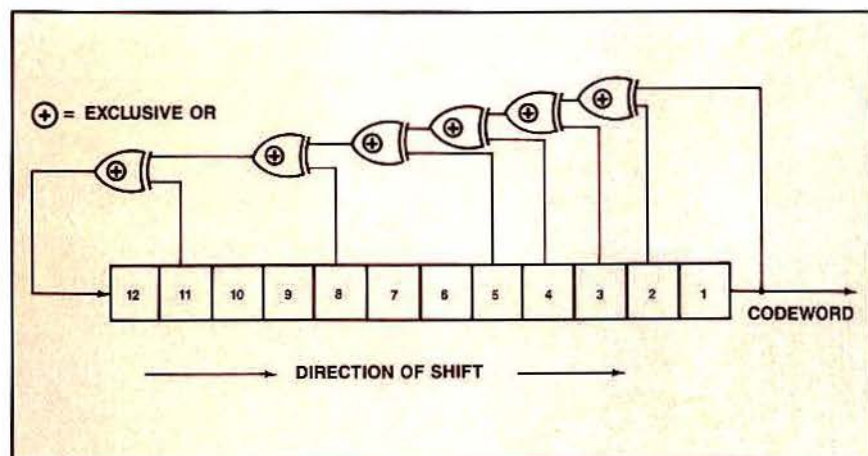


Figure 3. A Golay code encoder that uses a 12-bit shift register. The 12 bits of data are loaded into the shift register. Then the shift register is shifted to the right 11 times to generate a complete codeword.

The exponents of the X coefficients may be looked at as taps on a shift register. Encoding could be accomplished by an 11-stage shift register with feedback connections given by either polynomial. But because the data field is 12 bits long, the use of a 12-bit shift register is preferred.

Taking advantage of the cyclic property of the (23,12) code, the taps for a 12-bit shift register implementation can be calculated quickly. The generator polynomial for any cyclic code must be divisible by $X^N + 1$, where N is the length of the codeword. (It is this prop-

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Table 1—The bit pattern for all the DCS codes and their logical inverses.

DCS CODE	BINARY CODEWORD								INVERSE CODE
023	11	101	100	011	100	000	010	011	047
025	11	010	110	111	100	000	010	101	244
026	11	001	011	101	100	000	010	110	464
031	10	100	011	111	100	000	011	001	627
032	10	111	110	101	100	000	011	010	051
043	10	110	110	110	100	000	100	011	445
047	00	011	111	101	100	000	100	111	023
051	11	111	001	010	100	000	101	001	032
054	11	011	110	100	100	000	101	100	413
065	10	111	010	001	100	000	110	101	271
071	11	001	111	001	100	000	111	001	306
072	11	010	010	011	100	000	111	010	245
073	01	011	100	110	100	000	111	011	506
074	11	101	000	111	100	000	111	100	174
114	01	010	011	110	100	001	001	100	712
115	11	100	101	011	100	001	001	101	152
116	11	111	000	001	100	001	001	110	754
125	00	001	111	011	100	001	010	101	365
131	01	111	010	011	100	001	011	001	364
132	01	100	111	001	100	001	011	010	546
134	01	011	101	101	100	001	011	100	223
143	01	101	111	010	100	001	100	011	412
152	00	111	101	100	100	001	101	010	115
155	10	001	001	101	100	001	101	101	731
156	10	010	100	111	100	001	101	110	265
162	11	010	111	100	100	001	110	010	503
165	01	100	011	101	100	001	110	101	251
172	00	001	011	111	100	001	111	010	
174	00	110	001	011	100	001	111	100	074
205	11	011	101	001	100	010	000	101	263
223	11	010	001	110	100	010	010	011	134
226	11	110	110	000	100	010	010	110	411
243	10	001	011	011	100	010	100	011	351
244	00	111	111	010	100	011	100	100	025
245	10	110	001	111	100	010	100	101	072
251	11	000	100	111	100	010	101	001	165
261	00	101	110	111	100	010	110	001	732
263	10	111	101	000	100	010	110	011	205
265	10	000	111	100	100	010	110	101	156
271	11	110	010	100	100	010	111	001	065
306	00	011	001	111	100	011	000	110	071
311	01	110	001	101	100	011	001	001	664
315	11	011	000	110	100	011	001	101	423
331	01	000	111	110	100	011	011	001	465
343	01	010	010	111	100	011	100	011	532
346	01	110	101	001	100	011	100	110	612
351	00	011	101	011	100	011	101	001	243
364	11	010	000	101	100	011	110	100	131
365	01	011	110	000	100	011	110	101	125
371	00	101	011	000	100	011	111	001	734
411	11	101	110	110	100	100	001	001	226
412	11	110	011	100	100	100	001	010	143
413	01	111	101	001	100	100	001	011	054
423	10	010	111	001	100	100	010	011	315
431	11	011	000	101	100	100	011	001	723
432	11	000	101	111	100	100	011	010	516
445	11	110	111	000	100	100	100	101	043
464	01	001	111	110	100	100	110	100	026
465	11	000	001	011	100	100	110	101	331
466	11	011	100	001	100	100	110	110	662
503	01	111	000	110	100	101	000	011	162
506	01	011	111	000	100	101	000	110	073
516	10	000	011	011	100	101	001	110	432
532	00	011	100	011	100	101	011	010	343
546	00	110	011	110	100	101	100	110	132
565	00	011	000	111	100	101	110	101	703
606	10	111	011	001	100	110	000	110	631
612	11	001	110	001	100	110	001	010	346
624	00	011	110	101	100	110	010	100	632
627	00	000	011	111	100	110	010	111	031
631	11	100	101	000	100	110	011	001	606
632	11	111	000	010	100	110	011	010	624
654	10	011	000	011	100	110	101	100	743
662	01	001	000	111	100	110	110	010	466
664	01	110	010	011	100	110	110	100	311
703	01	000	101	011	100	111	000	011	565
712	00	010	111	101	100	111	001	010	114
723	01	110	011	000	100	111	010	011	431
731	00	111	100	100	100	111	011	001	155
732	00	100	001	110	100	111	011	010	261
734	00	011	011	010	100	111	011	100	371
743	00	101	001	101	100	111	100	011	654
754	01	000	001	111	100	111	101	100	116

erty that made the code cyclic in the first place.) Thus,

$$h(X) = g(X)/(X^{23} + 1)$$

Using the first polynomial,

$$h(X) = X^{12} + X^{11} + X^{10} + X^9 + X^8 + X^5 + X^2 + 1$$

The long division is shown in Figure 2 on page 50. Notice that the calculation is modulo-2-arithmetic, $1 + 1 = 0$ or, logically, an exclusive OR function. There are no negative coefficients in modulo-2 arithmetic.

Figure 3 on page 54 shows the logic implementation for the encoder. The 12-bit codeword is loaded *once* into the shift register. The shift register is rotated to the right. Because the code is cyclic, the shift register's original contents

Although DCS systems use the (23,12) Golay code, several restrictions are placed on codeword selection.

reappear every 23 shifts. Table 1 at the left shows the bit pattern for all the DCS codes and their logical inverses.

Although DCS systems use the (23,12) Golay code, several restrictions are placed on codeword selection.

First, to reduce the number of bits in the data field, three of the 12 bits are fixed. The remaining nine bits are represented by a three-digit octal (base 8) code. Figure 4 on page 58 represents the octal code graphically.

With the 12-bit data field of the (23,12) code, it would seem that 2^{12} or 4,096 codewords would be possible. But the *same* codeword appears in 23 different phases as it is sent sequentially.

As shown in Figure 4, an observer watching DCS codeword 331 would see



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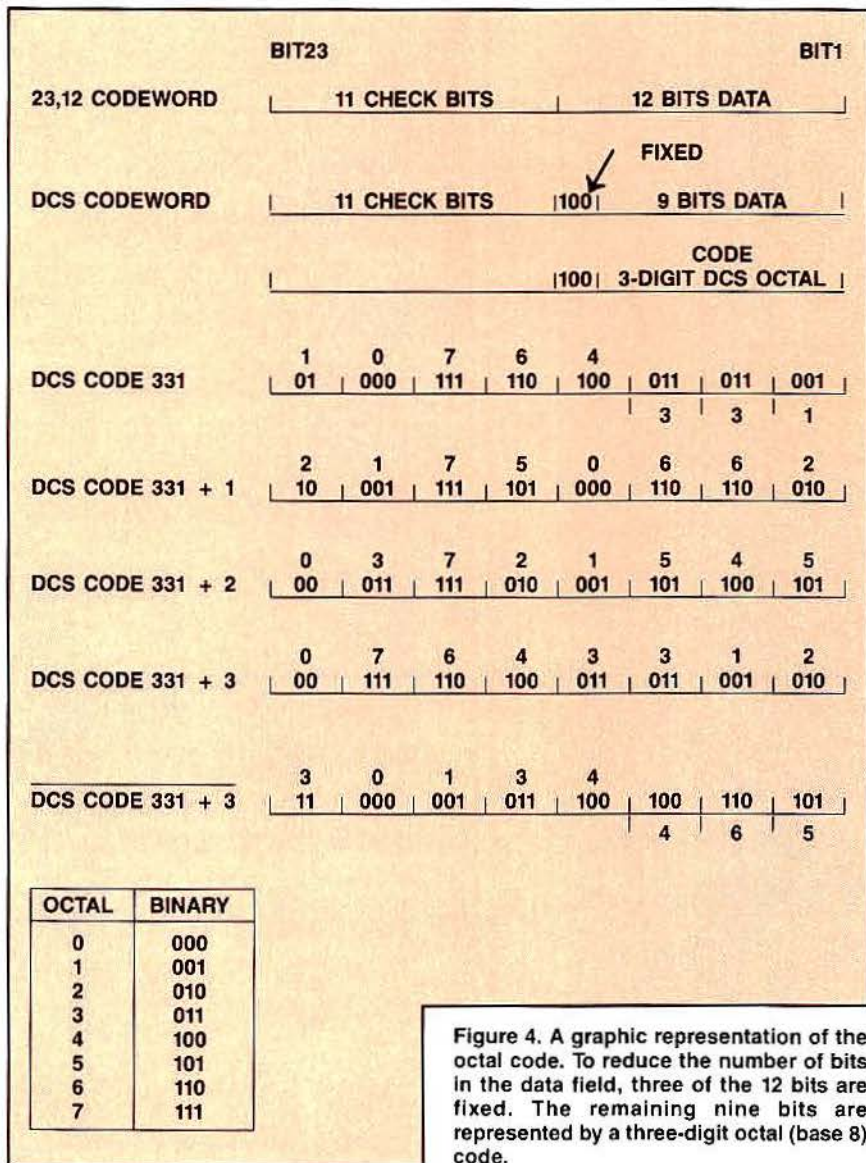


Figure 4. A graphic representation of the octal code. To reduce the number of bits in the data field, three of the 12 bits are fixed. The remaining nine bits are represented by a three-digit octal (base 8) code.

the octal codes 10764331, 03721545, 07643312, etc. The selection of the DCS codeword 331 includes 23 other phases of the same code. This limits the maximum codeset size to 178 possible codes.

Certain codes, such as those composed of all 1s and all 0s, convey no information. Other codes have equally undesirable properties. Ultimately, the codeset is reduced to 83 usable codes.

Although no proof was offered, previously it was stated that 41 DCS codewords are logical inverses of other codes. This can be seen by referring to Figure 4. For example, inverting the bit pattern for DCS code 331 in the third phase yields the DCS code 465. Table 1 can be used to verify the result.

The encoder diagrammed in Figure 3

is completely functional, provided it is clocked at the proper baud rate. The encoding task is equally simple for a microprocessor.

DCS signal spectrum

Because the 23-bit DCS codewords are repetitive, the encoded signal bandwidth consists of an infinite number of spectral components occurring every 5.8Hz. Because all DCS codewords are 23 bits long, an odd number, the spectrum contains a dc component.

Most of the DCS codewords' spectral power lies in a bandwidth from 6Hz to 41Hz, although several codewords have a majority of their energy concentrated above the ninth harmonic at 53Hz. Thus, an encode lowpass filter must be

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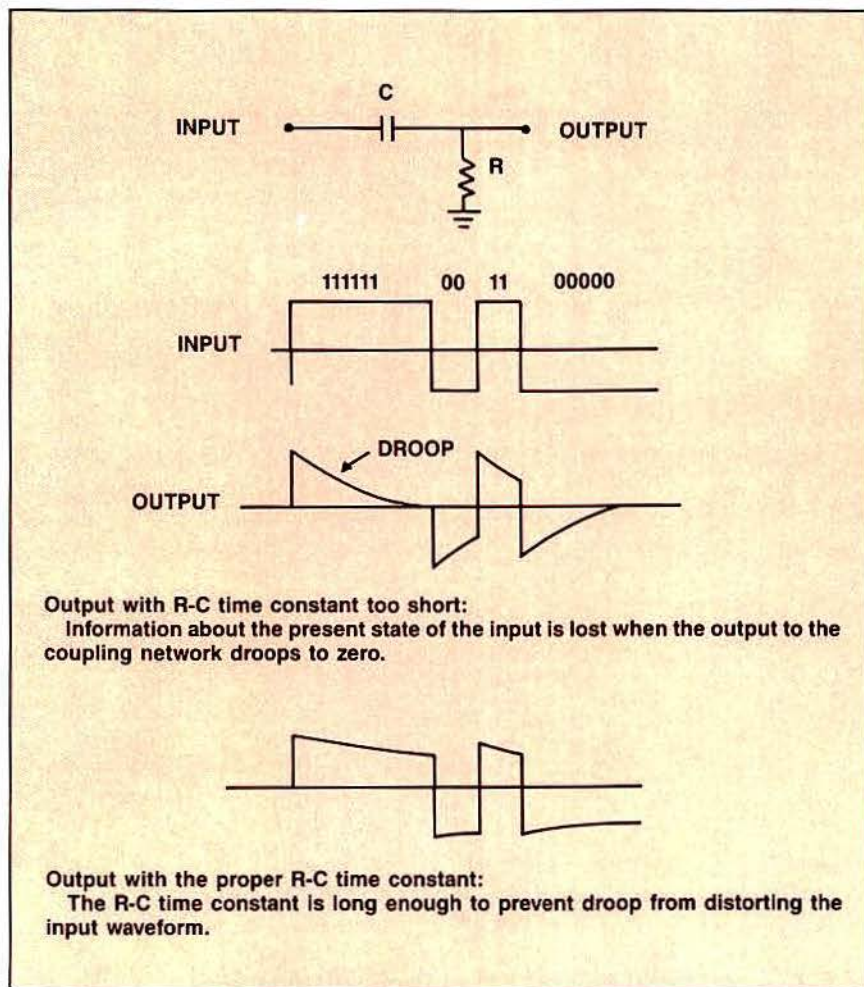


Figure 5. The R-C circuit analysis shows why a bandpass filter with a lower corner frequency of 6Hz may not be used as an encode filter.

used before the signal is applied to the transmitter modulator. Otherwise, the higher harmonics would be audible to the radio user.

But this situation should not be interpreted to mean that a bandpass filter with a lower corner frequency of 6Hz may be used as an encode filter. The simple R-C circuit shown in Figure 5 on the left shows why. A review of Table 1 reveals that many DCS codes have long strings of 1s and 0s. These strings may be as long as 6 bit times, or 45ms. In the circuit of Figure 5, the R component may be looked upon as the input impedance of a lowpass filter and the capacitor (C) value could be a dc blocking capacitor used to couple the signal into the filter. It can be seen that if the R-C time constant is too short, information about the present state of the input signal will be lost as the output droops to zero.

...certain radio transmitters and receivers must be modified before they are capable of DCS operation.

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Because DCS uses such long strings of 1s and 0s, almost all components in the transmitter and receiver chains must be coupled down to at least 2Hz or lower. This requirement means that certain radio transmitters and receivers must be modified before they are capable of DCS operation.

Phase modulators, in particular, need special consideration because they theoretically are incapable of being directly modulated by dc, unlike direct FM modulation methods.

Simply put, low frequency response is a requirement for DCS systems.

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890TT

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The 890TT is a burst-mode DTMF microphone with all the features of the 885TT, plus programmable functions, including:

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- Last number redial.
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Use downtilt selectively to improve system coverage

Use a handy computer program to calculate coverage areas for antennas with downtilt. Although downtilt can control a signal to improve radio communications and radiopaging coverage, the method has limitations.

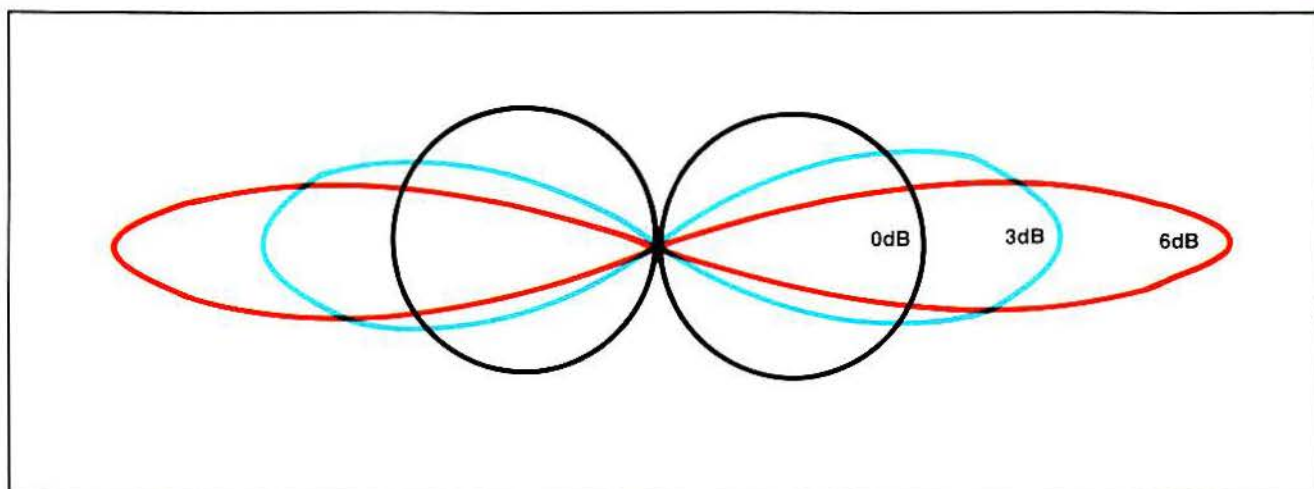


Figure 1. When antenna gain is increased, its vertical beamwidth narrows. More signal is directed toward the horizon and less is directed above and below the horizon.

By Andrew Singer

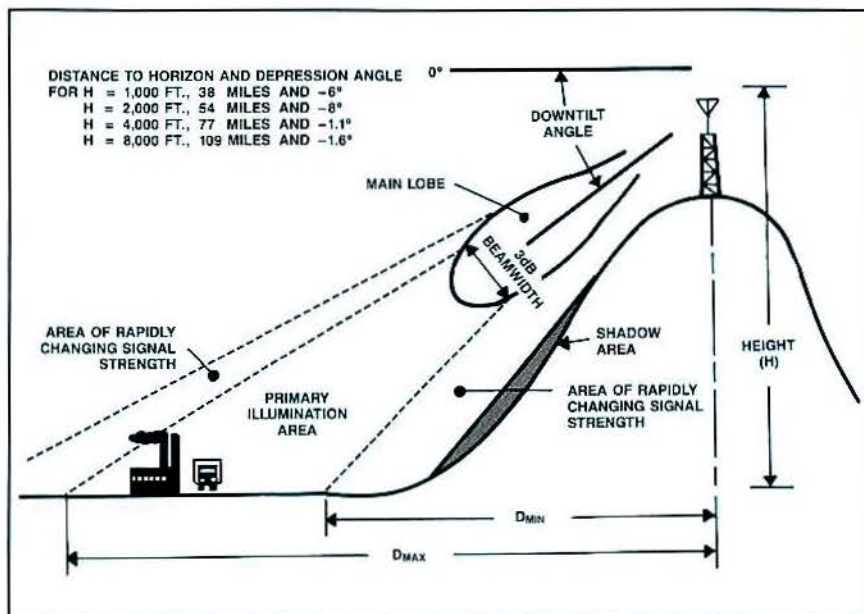


Figure 2. A typical mountaintop site shows a situation in which downtilt is beneficial. If no downtilt were used, the signal would overshoot the 'primary illumination area.'

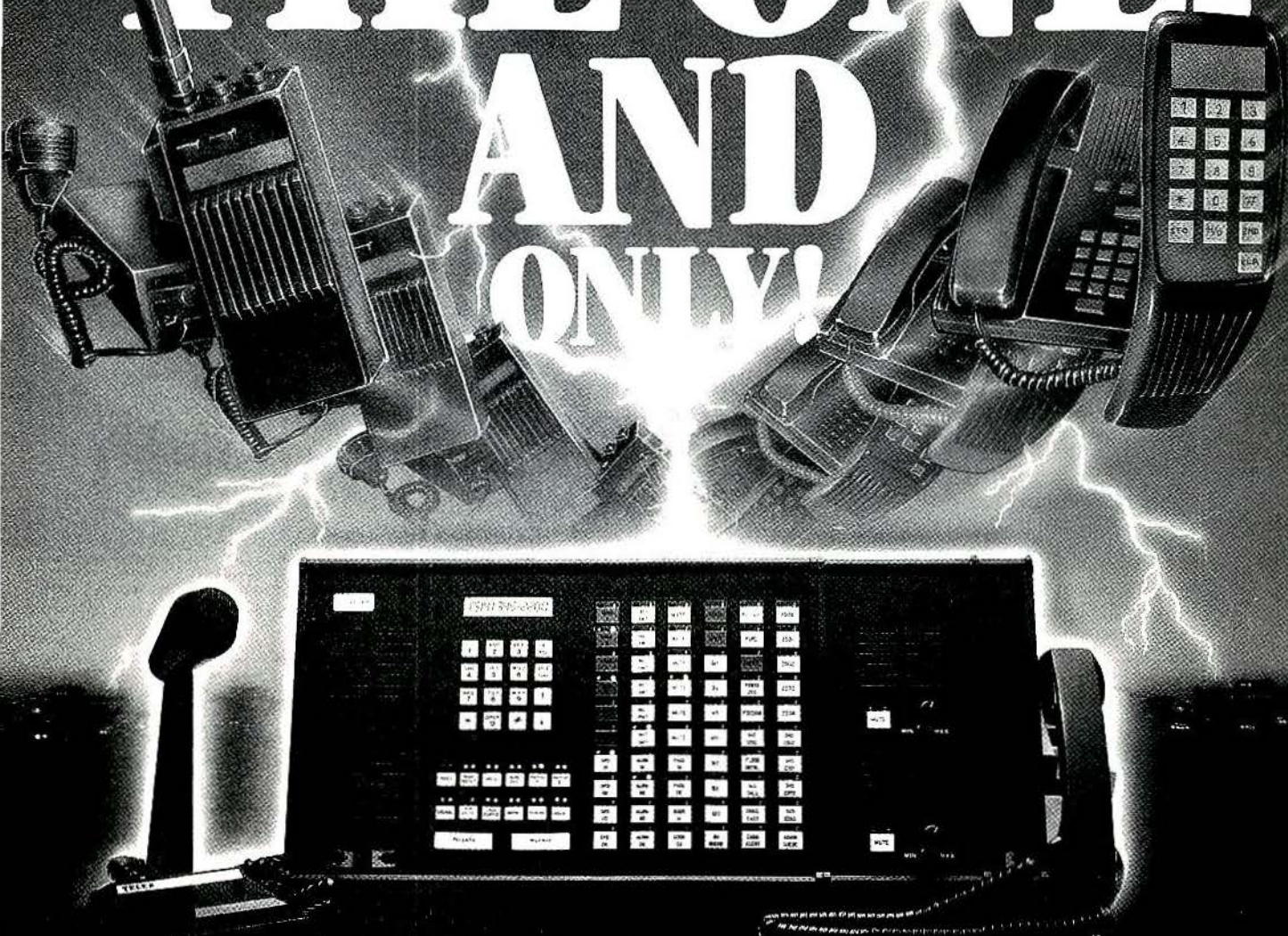
Should your radio communications or radiopaging system include an antenna with downtilt? If so, how much downtilt? The answers to these questions can make a large difference in your system's coverage.

Downtilt has become a "buzz word" in system design. Like the phrase, "state of the art," it gets used more often than it should. Although downtilt may deliver coverage in areas you never thought possible, it may *decrease* coverage when used in the wrong situation. Downtilt refers to the control of the signal such that its focus is directed below the horizon.

When omni gain is increased, the antenna's vertical beamwidth narrows. More signal is directed toward the ho-

Singer is senior applications engineer at Sinclair Radio Laboratories, Tonawanda, NY.

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```

1  REM DOWNTILT.BAS WRITTEN BY ANDREW SINGER 08/07/90
2  PRINT "COVERAGE DISTANCE CAN BE AFFECTED BY MANY FACTORS."
3  PRINT "THIS PROGRAM SERVES ONLY AS A GUIDE"
4  PRINT "FOR CHOOSING DOWNTILT VALUES.": PRINT
5  LPRINT "CONVERGENCE DISTANCE CAN BE AFFECTED BY MANY FACTORS."
6  LPRINT "THIS PROGRAM SERVES ONLY AS A GUIDE"
7  LPRINT "FOR CHOOSING DOWNTILT VALUES."
8  REM ** CALCULATIONS BASED ON FLAT EARTH. **
9  REM ** HEIGHT REFERS TO ELEVATION ABOVE AVERAGE TERRAIN. **
10 INPUT "PLEASE ENTER SRL MODEL NUMBER"; ANTENNA$
10 INPUT "PLEASE ENTER ANTENNA HEIGHT"; H
30 INPUT "PLEASE ENTER ANTENNA 3 dB BEAMWIDTH"; BW
40 LPRINT : LPRINT "ILLUMINATION DISTANCE IN MILES FOR "; ANTENNA$; " AT"; H; "F
EET"
50 LPRINT : LPRINT "DOWNTILT  DMIN      DMAX": LPRINT
60 FOR DOWNTILT = 0 TO 24 STEP 1
70   DMIN = (H / TAN((.5 * BW + DOWNTILT) / 57.3)) / 5280
80   ANGLE = DOWNTILT - .5 * BW
90   IF ANGLE <= 0 THEN 110
100  DMAX = (H / TAN(ANGLE) / 57.3)) / 5280: IF DMAX > 100 THEN 110 ELSE 120
110  LPRINT USING "### #####.## & &"; DOWNTILT; DMIN; " "; " >HOR": GOTO 130
120  LPRINT USING "### #####.## #####.##"; DOWNTILT; DMIN; DMAX
130 NEXT DOWNTILT
140 END

```

Figure 3. Use this computer program to make calculating coverage simple. The program prompts the user for an antenna model number, the height above average terrain and the 3dB beamwidth of the antenna. The program is written in basic language and should adapt easily to any computer.

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COVERAGE DISTANCE CAN BE AFFECTED BY MANY FACTORS.
THIS PROGRAM SERVES ONLY AS A GUIDE
FOR CHOOSING DOWNTILT VALUES.

ILLUMINATION DISTANCE IN MILES FOR SRL-480 AT 1000 FEET			ILLUMINATION DISTANCE IN MILES FOR SRL-329 AT 8000 FEET		
DOWNTILT	D _{MIN}	D _{MAX}	DOWNTILT	D _{MIN}	D _{MAX}
0	3.61	>HOR	0	11.51	>HOR
1	2.71	>HOR	1	10.14	>HOR
2	2.16	>HOR	2	9.05	>HOR
3	1.80	>HOR	3	8.18	>HOR
4	1.54	10.85	4	7.45	>HOR
5	1.35	5.42	5	6.83	>HOR
6	1.20	3.61	6	6.31	>HOR
7	1.07	2.71	7	5.86	>HOR
8	0.97	2.16	8	5.46	>HOR
9	0.89	1.80	9	5.12	57.87
10	0.82	1.54	10	4.81	34.71
11	0.76	1.35	11	4.53	24.77
12	0.71	1.20	12	4.28	19.25
13	0.66	1.07	13	4.05	15.74
14	0.62	0.97	14	3.85	13.30
15	0.58	0.89	15	3.66	11.51
16	0.55	0.82	16	3.48	10.14
17	0.52	0.76	17	3.32	9.05
18	0.49	0.71	18	3.18	8.18
19	0.47	0.66	19	3.04	7.45
20	0.45	0.62	20	2.91	6.83
21	0.43	0.58	21	2.79	6.31
22	0.41	0.55	22	2.68	5.86
23	0.39	0.52	23	2.57	5.46
24	0.37	0.49	24	2.47	5.12

Figure 4. This is a printed sample of the results from the computer program shown in Figure 3. The results show the primary illumination area for downtilt values from 0° to 24°.

hizon and less is directed above and below the horizon. Signal directed above the horizon usually is wasted, but signal directed below the horizon may be essential for close-in coverage. (See Figure 1 on page 62.) Directly under the antenna, little signal may be needed for adequate coverage because the short distance the signal must travel has low path loss.

Figure 2 on page 62 shows a typical mountaintop site. If no downtilt were used, the signal would overshoot the "primary illumination area."

To find the close-in edge of the coverage (D_{min}) and the far edge of the coverage (D_{max}) of the primary illumination area, these two formulas are used:

$$D_{min} = [\text{height}/\text{TAN}(.5 * 3\text{dB beamwidth} + \text{downtilt})]/5280$$

$$D_{max} = [\text{height}/\text{TAN}(\text{downtilt} - .5 * 3\text{dB beamwidth})]/5280$$

If the 3dB beamwidth is greater than the downtilt, the signal emanates toward the horizon.

Figure 3 on page 64 is a computer program that makes calculating the coverage simple. The program prompts the user for an antenna model number, the height above average terrain and the 3dB beamwidth of the antenna. The printer prints the primary illumination area for downtilt values from 0° to 24°.

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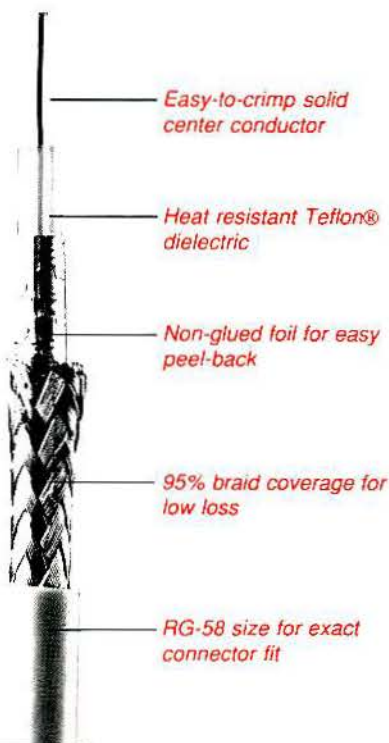
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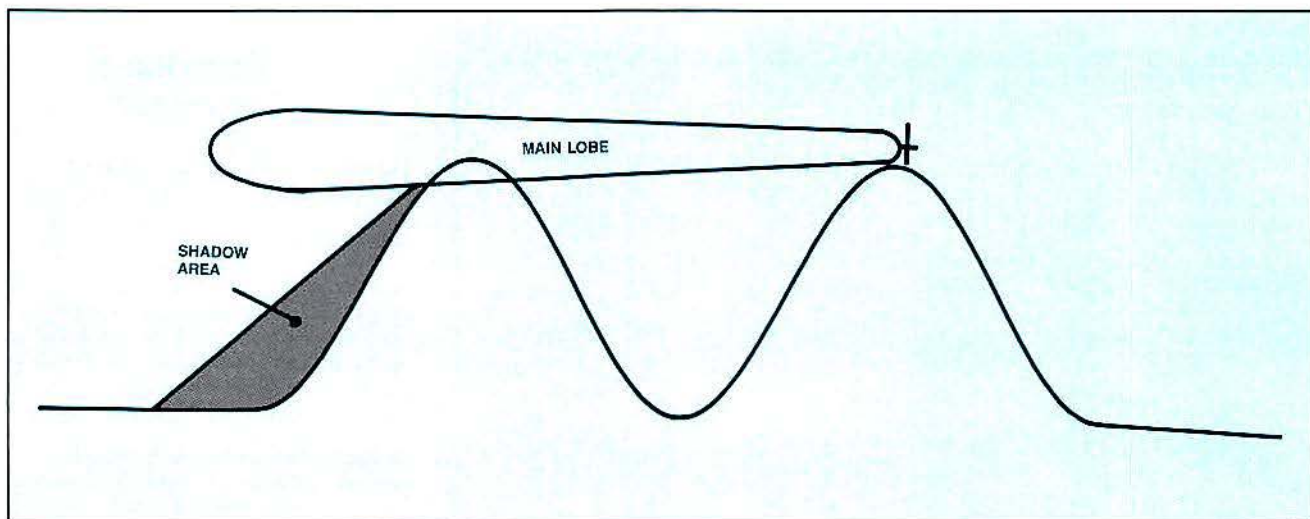


Figure 5. This diagram shows a situation that downtilt cannot fix. A ridge causes a shadow area in which the signal is weak. Only by relocating the antenna could adequate coverage be realized.

The program is written in basic language and should adapt easily to any computer. Figure 4 on page 65 is a sample printout.

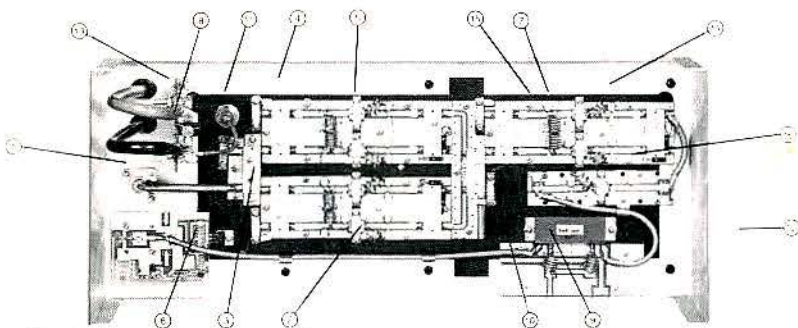
Typical situations

Paging companies sometimes place an

antenna on a rooftop to cover buildings in the vicinity. A high-gain antenna would not provide as much signal as possible inside the buildings. Such a situation would require a low-gain antenna to deliver as much signal as possible to areas below the antenna.

If a UHF system were on an 8,000-foot mountain and coverage were required for a town 5 miles away, a suitable antenna might be a model with 6dB gain and 10° of downtilt. D_{min} would be 4.8 miles, ensuring satisfactory coverage of the town. D_{max} would be 34.7 miles, adequate to fit the need and to reduce the chances of interfering with a co-channel system 100 miles away.

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Scattering

Although the use of downtilt can be an effective method for reducing interference, the amount of downtilt must be kept in perspective. If enough downtilt were used to reduce the signal at a distance of 5 miles, chances are the signal would be scattered to reach points beyond 5 miles. Scattering can cause havoc at close range.

Figure 5 above shows another factor to keep in mind. The diagram shows a ridge that causes a shadow area in which the signal is weak. The use of downtilt would not improve the signal in the shadow area. Only by relocating the antenna could adequate coverage be realized.

No cure-all

Downtilt tends to be used as a panacea for all "RF ills." Actually, downtilt is a problem-solver for a few special applications. Most antenna manufacturers have applications engineering departments that can help you to make decisions about the use of downtilt and other problem-solving techniques. 

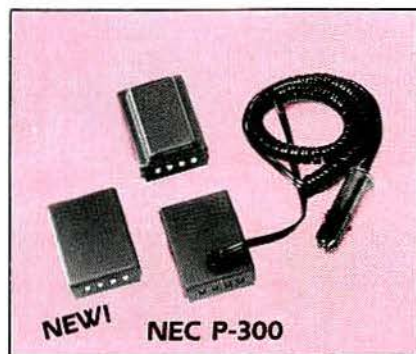
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4 paging carriers join Telocator, yield 2.6 million subscribers

Metromedia Paging, Paging Network, MobileComm and PacTel Paging have joined Telocator, a trade association that represents common carrier mobile telephone and paging service providers. Telocator is based in Washington, DC. The four paging carriers collectively represent more than 2.6 million paging subscribers in the United States.

MobileComm has rejoined the association after it left because of the group's "lack of initiative in supporting regional

Bell operating companies (RBOC) MFJ paging relief." In a Telocator board action on July 12, the association voted to support the lifting of MFJ restrictions on RBOC-affiliated paging companies that are members of Telocator, thus satisfying MobileComm and other RBOC-affiliated paging carriers.

The four paging companies are expected to participate in Telocator's legislative and regulatory paging actions.

Engineering society seeks papers for May 1991

The Institute of Electrical and Electronics Engineers (IEEE) Vehicular Technology Society seeks papers for presentation at its 1991 conference. Those who submit papers must agree to present them at the May 19-22, 1991 conference.

An abstract of approximately 250 words should be sent to: IEEE VTS '91

Conference Technical Program Committee, Dr. Edward Chien, c/o SBC Technology Resources, 550 Maryville Centre Drive, Suite 312, St. Louis, MO 63141.

For other information about the conference, call Jay Underdown, conference chairman, at 314-946-9980.

Johnson boosts interest in AmeriCom to 92%

E. F. Johnson, Waseca, MN, increased its ownership in Atlanta-based AmeriCom to nearly 92%. Terms of the transaction were not disclosed. Johnson remains the sole manufacturer of AmeriCom's trunked mobile network switching systems.

Hadron signs MDT licensing agreement

Hadron, Chantilly, VA, signed a two-year, non-exclusive licensing agreement with Simac Systems B.V., Veldhoven, Netherlands, for the purchase and resale of Hadron's mobile digital telecommunications message switch software. Simac intends to sublicense at least 15 message switch systems to European customers during the terms of the agreement. The license agreement provides Simac a fixed-base link between its mobile terminals, a variety of inquiry-based host computers and CAD host computers.

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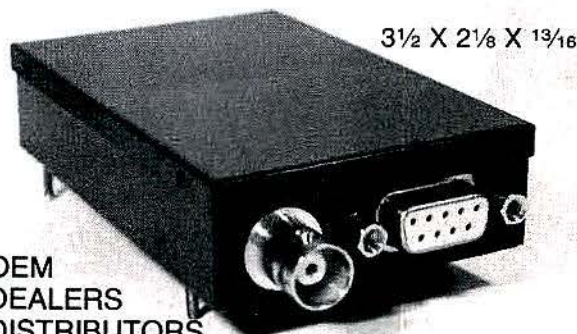
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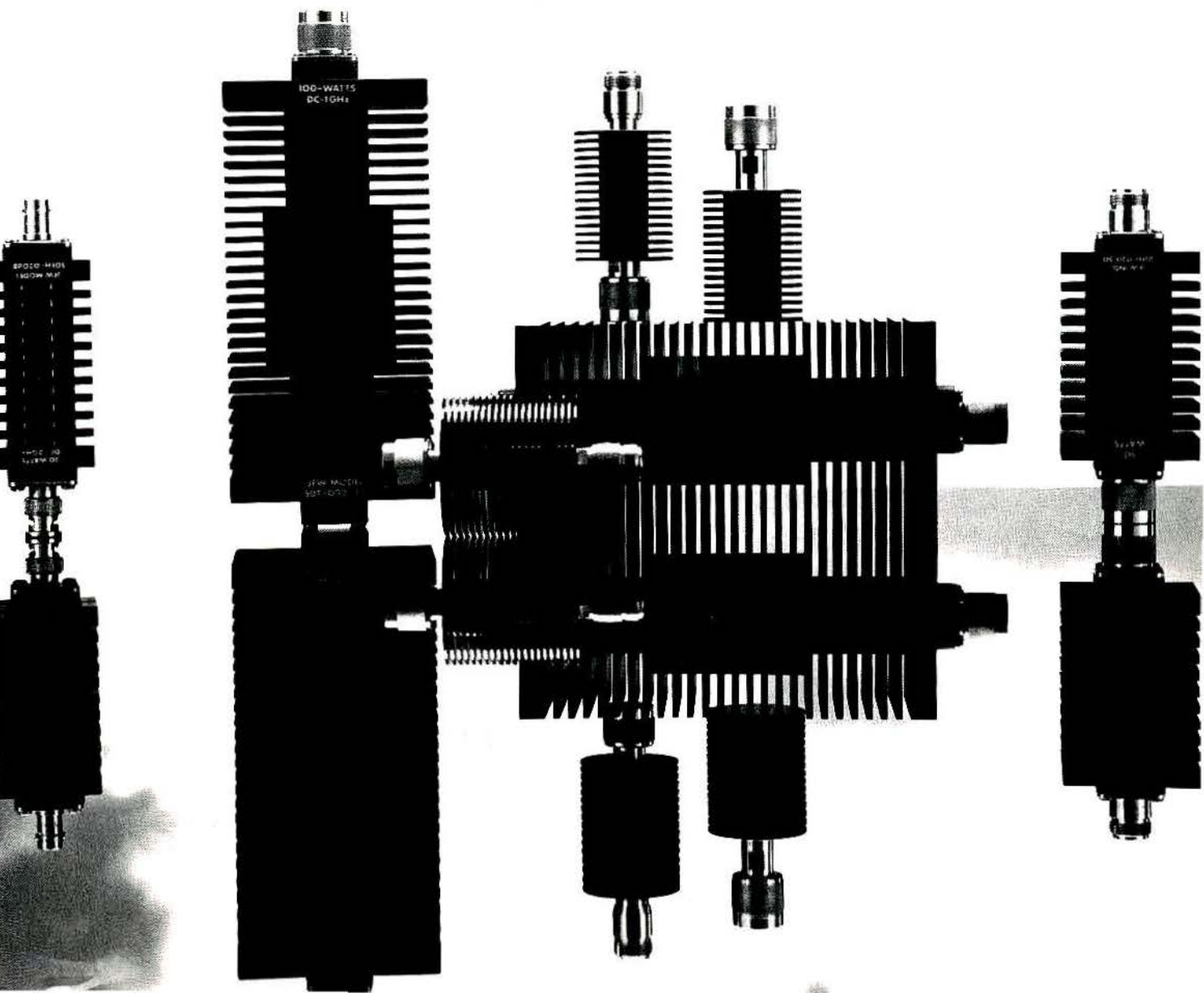


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Avtec, Ericsson-GE sign license pact

Avtec, Gilbert, SC, and Ericsson-GE Mobile Communications, Lynchburg, VA, signed an agreement that grants Avtec a non-exclusive license to develop product that is compatible with Ericsson-GE's 16 Plus enhanced public service trunking system.

Under the pact, Ericsson-GE will provide Avtec with technical data, including interfaces and protocols, that will enable Avtec's Access console sys-

tem to be compatible with the 16 Plus public safety trunked system.

The 16 Plus-compatible console system will be available from Avtec in early 1991.

In other action, Avtec opened a western regional office for sales and support in Salt Lake City. The office is at 12420 S. 2240 West, Riverton, UT 84065; phone: 801-254-9353.

BellSouth, Sears to market cellular phones, service

BellSouth Mobility, Atlanta, reached a retail sales agreement with Sears to offer cellular telephones and service to customers who shop at Sears stores in Alabama, Georgia, Florida, Kentucky, Louisiana, South Carolina and Tennessee. Mobile, portable, transportable and cellular mobile telephones from Motorola, Mitsubishi and NovAtel will be offered by Sears and BellSouth Mobility.

SRI Gallup division to recruit trade professionals

Recruitment pursuits, as well as developing existing telecommunications professionals, are goals of a new division of SRI Gallup, Lincoln, NE. The division targets cellular, paging and manufacturing markets specifically in the human resources area. Joseph Shaya serves as vice president of the division. The company is at 301 S. 68th St., Lincoln, NE 68510; 402-489-9000.

Relm reorganizes, establishes repeater, base station group

Relm Communications, Indianapolis, established LMC Systems, a separate group for its repeater and base station products. The separation of the land mobile product line allows the repeaters and base stations to be marketed independently from mobile and portable radios.

GE service zones add CAD system

Computer dispatching and remote radio terminals for consumer service trucks have been approved for use in approximately 130 General Electric Consumer Services (GECS) zones in the United States. The system uses vehicular mobile data terminals from Kustom Electronics, Overland Park, KS, and GE-Marc Tmx trunked or GE-Ranger UHF mobile radios. GE Consumer Services employs 3,500 service technicians and dispatchers.




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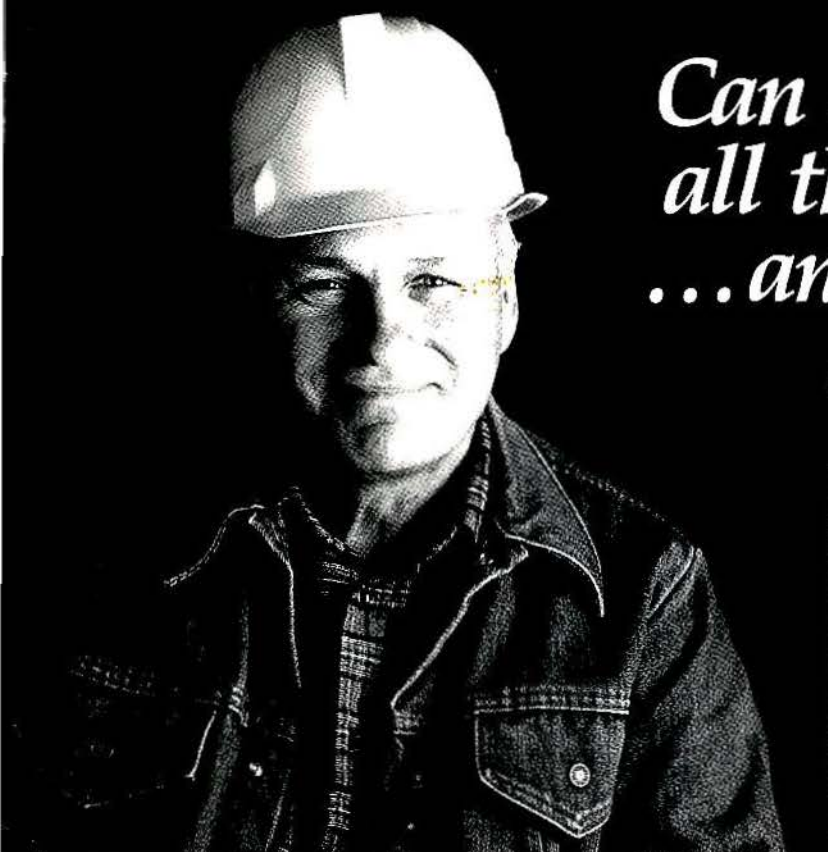
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An 8 hour / 500 mAh rechargeable battery, wall-type charger, flexible antenna and a metal belt clip are included with each radio.

Maxon also offers a vox (voice-activated) unit and headset, drop-in charger, external speaker / mic and a leather case as optional accessories.

And the list goes on, but the bottom line is this: Only the new CP-1000 series VHF and UHF two-way FM portable radios deliver these features and this level of performance at anywhere near the price.



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1989 — Maxon Electronics

Association membership combines tangible, intangible benefits

The Association of Communications Technicians (ACT) is a membership section of the National Association of Business and Educational Radio (NABER).

"Intangible" ACT membership benefits include a professional distinction for technicians that helps to elevate their employment status and compensation. NABER's government lobbying service helps to protect and to facilitate radio industry growth that creates opportunities for its members.

"Tangible" benefits include a magazine; two newsletters; a membership directory; a cloth identification patch; Dun & Bradstreet training programs; and discounts for purchasing books, long-distance telephone service and facsimile equipment.

Thomas Green, an ACT volunteer leadership council member, said most potential members consider only the tangible benefits in deciding whether



Chris Cavanagh: 'For the technicians, there are no hot issues on the Hill...'

membership is worth the annual dues—\$40 for general members (non-NABER-certified technicians) and \$50 for senior (certified) members. He said that some potential members he talks with tell him the value of the tangible benefits is not worth the dues. Yet the intangible benefits for technicians, including professional status, advancement opportunities and industry growth, are what led him to join ACT, Green said.

Chris Cavanagh, NABER's membership services coordinator, explained that NABER lobbies the FCC and Congress. "Issues are clearly drawn for two-way radio users, equipment dealers, specialized mobile radio (SMR) system operators and private carrier paging (PCP) system operators," he said. "For the technicians, there are no hot issues on the Hill, but issues that affect their organizations affect them, too."

Green said that current and potential members do not see "the grouping" ACT offers them as their professional society. He said the association needs to take steps to publicize the powerful combination of tangible and intangible benefits it offers to members.

Interference patrol

Responsibility for controlling interference on shared channels lies first with radio users:



- Listen before you transmit on a shared channel. Learn how to disable the squelch to listen for other users.
- Use your call sign whenever you use the radio.
- If you use a scrambler for privacy on a shared channel, sign off "in the clear" so other users know you are finished.
- Have your radio serviced periodically to be sure it is on frequency.
- Keep communications brief to promote harmony with other users who share the channel.
- Use the minimum transmitter power and antenna height you need to cover your area. That might be less than the power and antenna height specified on your license.

System operators:

- Post the name and 24-hour phone number of the site manager at the access point for each antenna site.

A public service message from

Mobile Radio Technology

Information

For information about ACT and technician certification, call 800-759-0300. Ask for 'technician services.'

Technician certification examinations will be offered at 120 sites in 43 states on the following schedule:

TEST DATES	REGISTRATION DEADLINE
Dec. 14 and 15	Nov. 16
1991	
Feb. 15 and 16	Jan. 11
March 15 and 16	Feb. 5
May 17 and 18	April 12
June 28 and 29	May 24

Radio common carriers win height, power increases

The FCC has modified height and power rules for radio common carriers (RCCs). According to the commission:

- At 43MHz, higher antennas will be allowed to reduce interference with TV receivers. Higher antennas reduce the near-field signal strength at ground level near the transmitter. Increased coverage reduces the number of transmitters required to cover a given area.

- At 150MHz and 450MHz, the potential for interference to adjacent-channel private radio carriers operating on 152.240MHz, 152.840MHz, 158.70MHz and 454.025MHz does not warrant the current, lower power limit.

- At 35MHz, 150MHz and 454MHz, RCCs may boost transmitter power above 500W ERP along radials whose average height above the terrain exceeds

500 feet, according to a formula for calculating an interference contour for the higher power level.

- At 931MHz, RCC antenna height and transmitter power may be increased, according to a new minimum separation distance table.

- At 931MHz for nationwide paging, transmitter power may be increased to 3,500W.

U.S., Canada work to set coordination guidelines

Members of the FCC and its Canadian counterpart, the Department of Communications, have met to develop spectrum allocation guidelines to coordinate exclusive radio communications channels for U.S. and Canadian use.

Two agreements are expected to result. One would cover public safety communications in the 896MHz-to-901MHz and 935MHz-to-940MHz band segments. The other would cover 821MHz-to-824MHz and 866MHz-to-

869MHz segments, which in the United States includes specialized mobile radio, business and land transportation radio services.

Work continues with respect to other frequencies governed under FCC Part 90 rules. Presently, the rules place restrictions on certain radio uses, including outright prohibition of use near the Canadian border pending the outcome of the negotiations.

FCC issues licenses for PCN experiments

Personal communications networks (PCNs) will be tested under the authority of experimental, developmental licenses the FCC has granted to as many as 15 companies.

PCNs are intended to offer portable telephone service that includes features similar to cellular telephone roaming in geographic scope and cordless telephone size in convenience.



Introducing:



Mic-Coder 6



DMV-6

IMTS



UED-6K
for King portables



UED-6

Midian's new IMTS modules, microphones, and dash mount boxes support the following features:

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- Deadbeat disable
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- Ten number repertory dial
- Scanning for synthesized radios
- Busy lockout and Time out timer
- Auto or manual call queuing
- Automatic disconnect

The UED-6/Mic-Coder-6/DMV-6 series also supports 2805 Hz, 1500 Hz, and 600/1500 Hz.

UED-6 modules: \$129.95, King modules: \$139.95, microphones and dash mount boxes: \$169.95.

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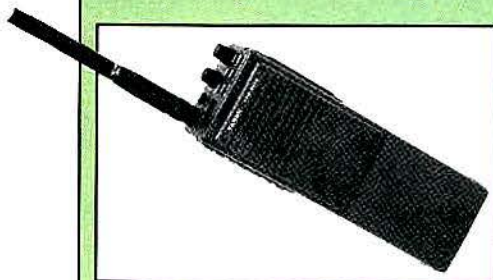
MIDIAN

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Readers' choice

Of all the new products and services covered in the April issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, here is your opportunity to acquire more information on them: Just circle the corresponding Fast Fact Card found in the back of this issue and mail the card to us.

Dual-band portable receives intrinsically safe rating



The FTH-2070 dual-band VHF and UHF portable radio from Yaesu is rated intrinsically safe for use in Class I, Division I, Groups A, B, C and D; and Classes II and III, Division 2, Groups E and G. The FTH-2070-16IS features a 30MHz frequency range and as many as 32 channels.

Circle (445) on Fast Fact Card

Cellular portable phone offers 30-number storage



The PT500 cellular portable phone is about wallet size when it is folded. The Motorola phone features 75 minutes of continuous talk time and as much as 20 minutes of standby time; 30-number storage; last-number redial; scratchpad memory; automatic lock; cumulative call timer; and adjustable volume control. Accessories include an overnight charger, standard battery and a carrying case.

Circle (447) on Fast Fact Card

Radio modem comes with built-in printer

The AR-2400 high-speed radio modem features a built-in printer that prints incoming messages in real time or stores them into memory for printing later. The AOR modem can be added to existing voice grade radio systems without modifications. Features include eight customized answering buttons, data sound mute switch, voice-data switch and mic connector.



Circle (446) on Fast Fact Card

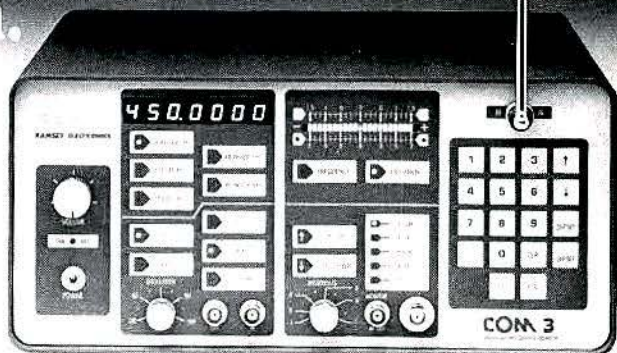
COM-3 SERVICE MONITOR

When you see your techs standing in line waiting for the service monitor, you know your profit line is parked... and in idle. Now, with the remarkable low cost of the new Ramsey COM-3, you can have a service monitor on every bench. COM-3 can turn wasted idle time into new found "profit" time. In addition, COM-3 will easily turn a profit in the field. Engineered as a

At \$2795, you can put one on every bench.

rugged, full featured portable, the rechargeable COM-3 will take your services where others can't. And, with its advanced microprocessor circuitry, COM-3 speeds your techs' testing capabilities, keeping your profit line moving... in full gear.

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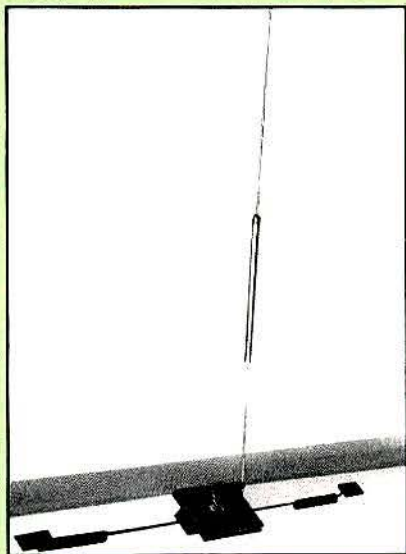
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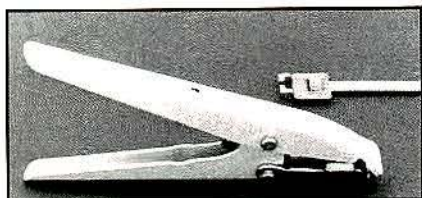
Dual-band mobile antenna features glass-mount



The VHF-UHF dual-band antenna from **Mobile Mark** features glass-mount style and operation on two non-harmonically related frequencies. Either band can be tuned without retuning the other band. The antenna transmits within a 150W capacity.

Circle (448) on Fast Fact Card

Cable tie tool bundles strands to optimum holding



The cable tie tensioner, a pocket-sized tool, aids in bundling cable to its optimum holding power. The **Band-It** tool applies the reusable E.V.A. stainless cable ties with a squeeze of the handle.

Circle (409) on Fast Fact Card

THE "ORIGINAL"

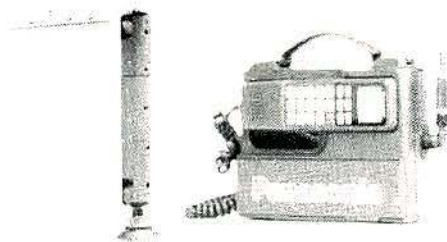
SMC was the first company to manufacture and market the popular "Tilt-Swivel" Pedestal Mount for the Cellular Communications Industry.

SMC is continuing its leadership in the Cellular Mount Market with the introduction of new product—in answer to installation opportunities. SMC makes Mounting Plates for the industry's most popular models of Portable and Transportable cellular phones.

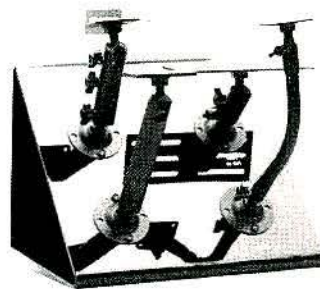
Display samples of SMC's wide variety of installation hardware, including our Portable and Transportable Plates are available. Contact your distributor—or call SMC Electro-Mount for additional information on our complete line of Plate options and Point-of Purchase Displays.



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Circle (66) on Fast Fact Card

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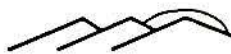
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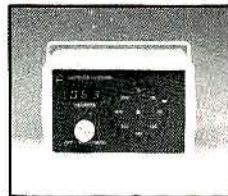
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Circle (67) on Fast Fact Card

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- ★ Stuck Microphones
- ★ Cable TV Leaks
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New Technology (patented) converts any VHF or UHF FM receiver into a sensitive Doppler shift radio direction finder. Simply plug into receiver's antenna and external speaker jacks. Models available with computer interface, synthesized speech, fixed site or mobile - 108 MHz to 1 GHz. Call or write for details.



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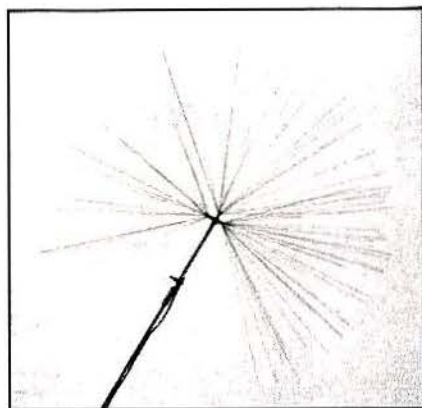
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Circle (68) on Fast Fact Card

New products

Lightning protector mirrors multipoint design

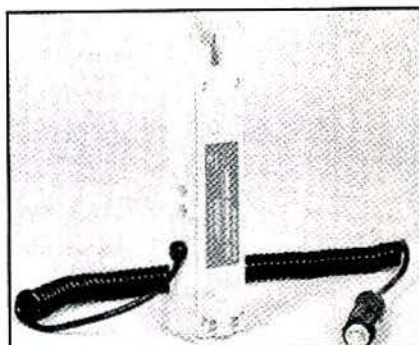


The Spline Ball Ionizer lightning protection device is designed to drain the electrostatic potential from structures as a safeguard from lightning damage. The **Lightning Eliminators & Consultants** multipointed metal terminal may be used alone or with other protection devices.

Circle (425) on Fast Fact Card

Travel battery eliminator, charger suits Motorola phones

The Unipak travel battery eliminator and charger from **Unitech Industries** works with Motorola 8000 series and Ultra Classic phones. It is 1-inch thick and fits between the phone and the battery. The circuitry fully charges the battery while permitting use of the phone by plugging into any standard cigarette outlet. The unit's call-in-progress monitor allows power disconnects without dropping a call.



Circle (413) on Fast Fact Card

Remote monitoring system controls temperature

The Pyramid System Guard controls temperature in remote buildings, as well as monitors alarms and building intrusion. The solid-state system from **Professional Systems** includes self diagnostic, comfort mode for service personnel and real-time functions.

Circle (419) on Fast Fact Card

VHF, UHF portables cover as many as 16 channels

The Citadel series of VHF and UHF portable radios are built to withstand rugged treatment and comes with a five-year warranty. They are available in 6-channel and 16-channel frequency synthesized models. The **Fujitsu Ten** 1-pound units are made of durable metals.

Circle (404) on Fast Fact Card

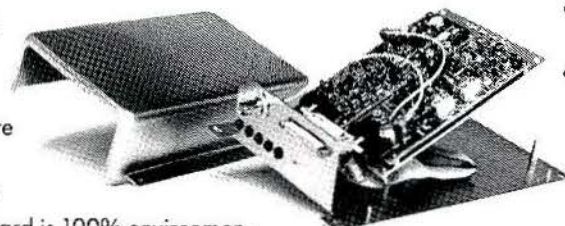
By the time you read this...

...the new DCL 1200 radio/modem transceiver by Neulink will have already transmitted your data at a phenomenal 1200 bits per second in full duplex or half duplex configurations.

Neulink's DCL 1200 uses VHF, UHF, and 960 Mhz FM radio channels to transfer data between computer terminals, and provides an interface for any RS-232-C (V.24) data application.

Plus, the DCL 1200 eliminates the need for expensive leased lines, resulting in maximum economical radio operation.

- Each unit is 100% hand tested
- IBM PC Compatible-Communications software optional
- Heavy duty industrial enclosure
- Separate transmit, receive, modem and RS-232-C boards
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- Adjustable RF power levels, 0-2 watts
- Operates on 12 VDC or optionally 100/110/220/240VAC, 50/60hz, and is fully UL, CSA, VDE approved
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- Full duplex and repeater operations optional

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Circle (69) on Fast Fact Card

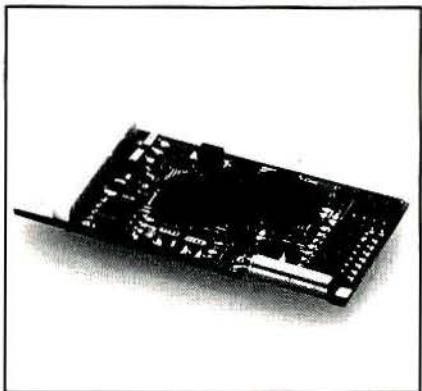
Radiotelephone interconnect includes autodial, toll-restrict



The PatchMaster 200 radiotelephone interconnect enables receipt of telephone calls from mobile and portable radios. The **Advanced Computer Controls** interconnect includes simplex sampling, VOX, full-duplex and repeater operation. The patch includes autodial, toll-restrict, synthesized and recordable voice prompts, and support for two phone lines.

Circle (426) on Fast Fact Card

DTMF decoder offers 1 to 7 digit code



The ST-807 miniature universal DTMF decoder from **Selectone** replaces the company's ST-806. It includes an on-board connector and cable assembly for easy installation. Other features include one- to seven-digit code capability and primary and secondary address codes. The unit works for mobile and portable applications and operates at 5.5Vdc to 25Vdc.

Circle (385) on Fast Fact Card

Cordless antenna works with cellular portables



The IVR-3 passive repeater cordless antenna from **Ora Electronics** mounts on a vehicle's glass for portable cellular phone usage inside a vehicle. The antenna requires no cable, drilling or power "hook-up." The unit features 3dB gain on the mast and 4dB forward gain on horizontal components.

Circle (323) on Fast Fact Card

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Circle (70) on Fast Fact Card

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DB812F Omni DSD™ 12 dBd 806-960 MHz Base Antenna

With its 3-inch Horizon Blue™ fiberglass radome, Decibel's Dual Skirt Dipole™ antenna resists winds to 150 mph, with one-half inch of icing.

Specifications

Range: 806-960 MHz
Bandwidth: up to 110 MHz
Gain: 12 dBd
Downtilt: 5° built in
VSWR: 1.5 to 1 or better
Power: 500 watts max.
Impedance: 50 ohms
Length: 206" or 200"
Flange: Fixed

Other features include dipole collinear arrays, a 28-inch aluminum alloy extension pipe for mounting, a grounding brass tube from top to bottom for lightning protection, and drain plugs for moisture evacuation.

All radiators, feed and matching system components are made of copper or brass, which reduces intermodulation when several transmitters are combined on the same antenna.

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Circle (71) on Fast Fact Card

New products

Communications structure boasts lightweight, durability

The L.E. Hut portable equipment shelter with Acrocrete finish has one-third the weight of concrete structures. The **Professional Systems** buildings offers durability and effective insulation. It is bullet-proof to 30.06 point-blank range.

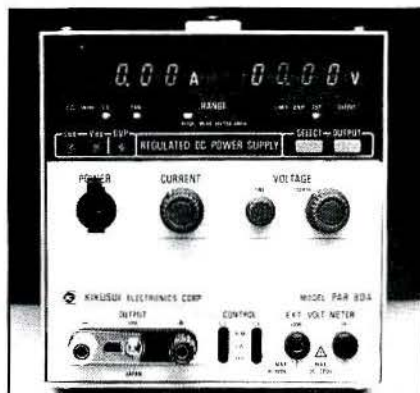
Circle (418) on Fast Fact Card

CW identifier has 11 programmable features

The CW radio station identifier from **Sierra Digital** offers microprocessor control, 11 programmable features, non-volatile memory, automatic ID, four programmable CW messages and 12Vdc operation.

Circle (428) on Fast Fact Card

Power supplies deliver wide range coverage



PAR series power supplies from **Kikusui International** provide automatic step-wise adjustment of current in accordance with the output voltage delivered. The PAR80A delivers 80W in four ranges, and the PAR160A provides 160W in three ranges.

Circle (449) on Fast Fact Card

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Maximize your performance with the ease and comfort of hands-free radio operation! DTC's advanced line of communication accessories are built to perform in the toughest conditions. Experience Engineering Excellence!

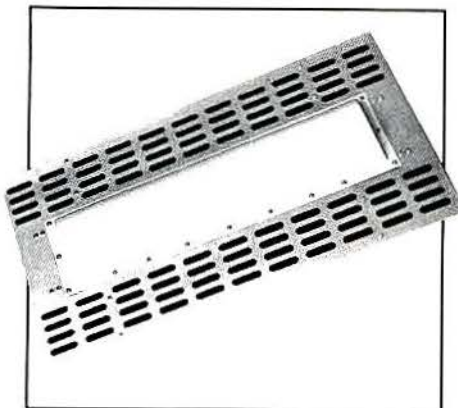
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Circle (72) on Fast Fact Card

800MHz-900MHz antenna covers 100MHz bandwidth



The PD10176 105° sector directional antenna for 800MHz and 900MHz covers a 100MHz bandwidth with a 9dB gain. The **Celwave** antenna is available with 3° or 6° electrical downtilt. The AMPS antenna features a side-fed phased dipole and strip line feed system for low insertion loss. It has a slotted reflector, and an ABS radome protects radiating elements from harsh environments. The antenna comes with mounting brackets for AMPS monopole platform use; tower leg mounting brackets are available.

Circle (368) on Fast Fact Card

3dB, 5dB portable antennas clip on vehicle's window

The Mobile Mark clip-on portable cellular antenna line includes fixed-whip units in 3dB and 5dB gain models. The antennas can be transported from vehicle to vehicle.

Circle (375) on Fast Fact Card

3W portable offers programming capabilities

The MTL 16 Plus portable radio offers 3W output and rugged, all-weather housing. It features field and PC programmability and is available from **Ericsson GE Mobile Communications**. The portable has four call buttons that can be preprogrammed for individual and group calls, as well as radio-to-telephone calls. Any combination of 16 systems, groups or both in



trunked and conventional functions may be accessed by a 16-position selector knob.

Circle (432) on Fast Fact Card

Monitor permits analysis, frequency logging



A computer-driven frequency logging and analysis system is available from **Ace Communications**. The package includes a receiver that covers 100kHz to 2,036MHz, control software and serial interface hardware. The system permits monitoring and logging of any group of frequencies within the receiver coverage range in wideband FM, narrowband FM, AM or single-sideband operating modes.

Circle (424) on Fast Fact Card

Link transmitters, receivers operate on 12.5kHz channels

Two radiolink transmitters and an upgrade to the RL-900 radiolink receiver line are available from **Glenayre Electronics**. All are designed to operate on newly released 12.5kHz channels. The QT-5996-NB is a 45W transmitter, and model QT-6996-NB is a 150W transmitter. The transmitters and model RL-900-NB receiver suit radiolink applications for paging systems or as data links between remote locations.

Circle (414) on Fast Fact Card

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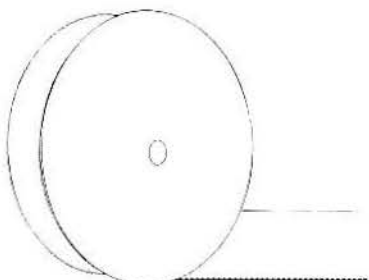
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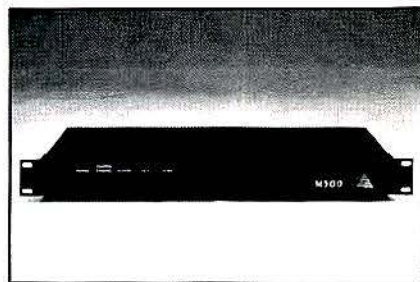
Our pricing is competitive and we offer quantity discounts whenever possible. There is never a minimum order required. Using **Communications Associates** means you do not have to place a large order with a supplier to receive favorable pricing. Our objective is to save you money so that your business can operate more efficiently and profitably.

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New products

Airtime logger fits Motorola systems



Model M-500 airtime logger fits Motorola systems. It features on-line statistics, all trunks busy viewing and busy queue statistics. The **Trident Micro Systems** unit logs as many as 550 hours of airtime per ID code in two time periods. Programming is done remotely or at the site. Logged data are stored indefinitely without loss in case of a power failure. Dual password protection is included.

Circle (401) on Fast Fact Card

2W, portable sports two channels, rugged design



Model 70-132 VHF version and model 70-232 UHF unit from **Midland LMR** have 2W and two channels. The crystal-controlled portables feature preset automatic noise squelch and optional CTCSS. The radios meet military standard 810C and D for shock and vibration. The rugged units come with belt-clip backs and are available with various accessories.

Circle (420) on Fast Fact Card

Circle (75) on Fast Fact Card

Universal counter-timer finds frequencies



Model UTC 8030 universal counter functions as a benchtop frequency counter and a portable frequency finder. The tester from **Optoelectronics** features a signal strength indicator, an audio annunciator, 1mV sensitivity, 1Hz resolution and 1Hz-to-3GHz range.

Circle (430) on Fast Fact Card

50Ω attenuators feature programmability

Hybrid plug-in 50Ω attenuators are programmable and available in a frequency range of 50MHz to 500MHz. Attenuation for these **JFW Industries'** devices are 0dB to 31dB in 1dB steps. Switching speed is five microseconds.



Circle (454) on Fast Fact Card

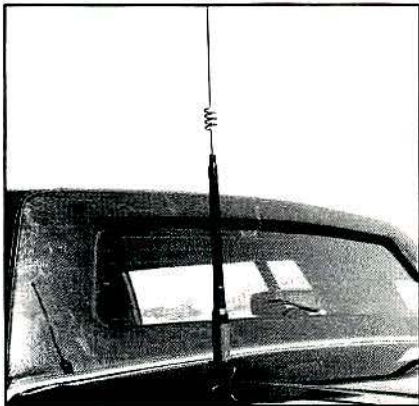
Digital recording system features ANI, monitoring

The DDR 2000 digital dispatch recorder from **Lanier Voice Products** features monitoring capabilities for supervisors; ANI; and as much as 320 minutes dispatch recording time for a standard four-station dispatch center.

Circle (421) on Fast Fact Card

Trunk-mount antenna comes with hidden spring

The Silhouette DB777X elevated feed trunk-mount antenna from **Decibel Products** offers 3dB gain and a 2-inch hidden spring at the base. The spring allows the antenna to bend when it is struck; otherwise the antenna remains vertical at normal driving speeds. The



antenna is available in black matte—DB777X; with a chrome whip—DB777XC; and with a black gold whip—DB777XG. The mobile antenna handles 50W input for 806MHz-to-894MHz conventional, trunked and cellular radios.

Circle (403) on Fast Fact Card

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Circle (76) on Fast Fact Card

New products

VHF, UHF portables use small, high-energy batteries, meet military specs

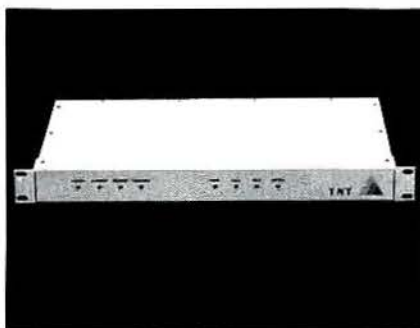
Two-way FM portables from Midland LMR are available in UHF and VHF and range from basic, economical units to high-capability hand-helds. More than 30 models make up the newest line, with all models using small, high-energy batteries. All models meet military specs 810C and D. At the simple level, models include sturdy 2W units with one or two channels and auto-



scuelch. At the sophisticated end are high-capability Syn-Tech XTR models with 5W output power, 99 channels that are programmable in groups, tone and digital squelch, DTMF signaling and priority scan. The portable line includes a wide range of costs and capabilities. Various options are available for the hand-helds.

Circle (378) on Fast Fact Card

Logic controller includes dual password protection



The TNT-100 logic and interconnect controller from Trident Micro Systems has built-in audio commanding and collects as many as 5,000 interconnect calls. The controller logs airtime in six time periods for as many as 20 channels. The unit incorporated dual password protection. Model TNT-80 logic controller has the same features as the TNT-100 without the interconnect.

Circle (390) on Fast Fact Card

Surge protectors offer low insertion losses

Surge protectors with coaxial connections by Citel America include N, BNC and UHF types in all male-female connection combinations. The protectors use a coaxial gas tube that allows a high frequency range. The protectors provide low insertion losses and low standing wave ratio. They offer a high sparkover voltage and come in a variety of breakdown voltages from 90V to 350V.

Circle (417) on Fast Fact Card

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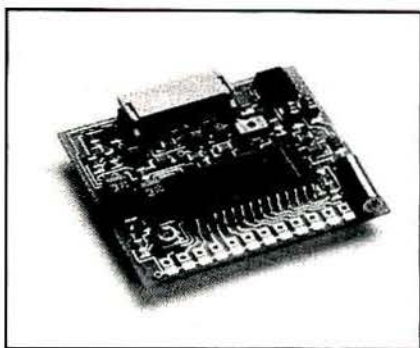
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Circle (78) on Fast Fact Card

Digital encoder-decoder uses surface-mount devices



Circle (386) on Fast Fact Card

The DCS-23 digital coded squelch encoder-decoder fits most portables and mobiles. The board is constructed with surface-mount components, and industry standard digital codes are field-programmable using PCB jumpers. The **Communications Specialists** board incorporates a crystal-controlled CMOS microprocessor, and connections are made with color-coded jumper wires connected to a microminiature plug and socket.

Dual-port desktop charger services Motorola batteries

The Unicharge dual-port desktop charger from **Unitech Industries** recharges Motorola 8000/9000 and Ultra Classic series phone batteries. The regulated trickle charge port accepts either size phone with battery. The fast charge port charges slim, regular size batteries in an hour and double high-capacity battery packs in under two hours.

Circle (412) on Fast Fact Card



Radiolink combines voice amp, portable



The Loudmouth radiolink from **Earmark** combines the functions of the unit's voice amplifier with a user's portable radio. The radiolink is powered by its own 9V alkaline battery and is listed as intrinsically safe by UL. The radiolink connects to most popular portable radios using patch cords, which are available from the company.

Circle (423) on Fast Fact Card

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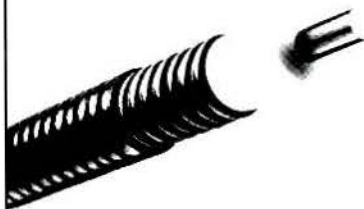
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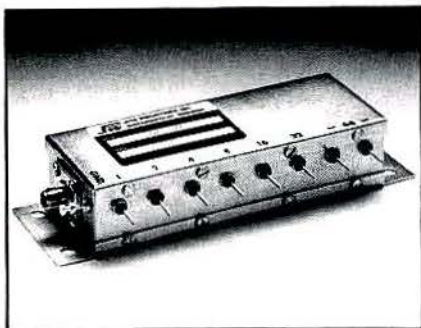
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GC11

Circle (58) on Fast Fact Card

New products

Programmable attenuators have various connectors



Programmable attenuators from **JFW Industries** are available in 50Ω, and some units come in 75Ω. Model 50P-076 spans dc to 1,000MHz with an attenuation of 0dB to 127dB in 1dB steps. Other models possess different specifications. Model 50P-591 offers a frequency range of dc to 3GHz. The attenuators come with BNA, SMA or N female connectors.

Circle (416) on Fast Fact Card

DTMF decoder permits 14 programmable features

The TTD-4D DTMF decoder from **Sierra Digital** includes microprocessor control; wrong digit reset; 14 programmable features; low power CMOS design; one- to 11-digits selective call; group call; all call; timed automatic reset; built-in self test; and 12Vdc operation.

Circle (429) on Fast Fact Card

Rapid charger boards fit NEC portables

The RC-3 and RC-9 rapid charge battery assembly boards from **DesignTech Systems** replace the charger board in NEC's P9000/9100 and P-300 cellular portables. The rapid charge board fully charges a battery in less than four hours. After a battery is charged fully, the unit switches to trickle charge.

Circle (359) on Fast Fact Card



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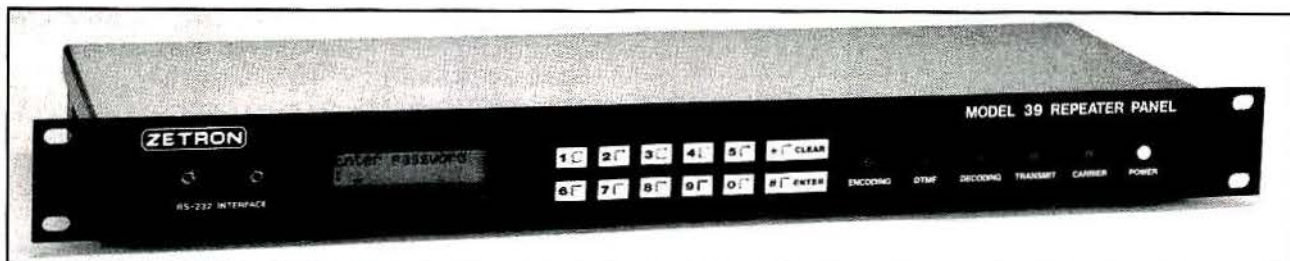
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Circle (80) on Fast Fact Card

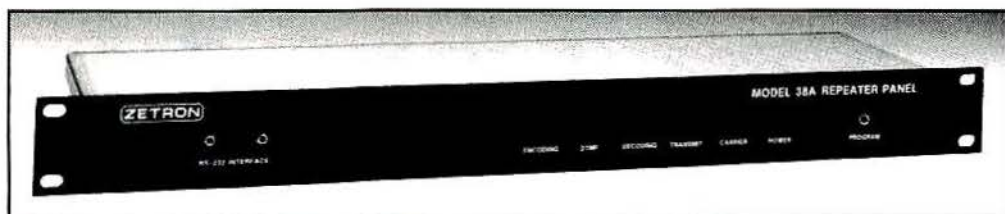
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THE BOTTOM LINE ■■■

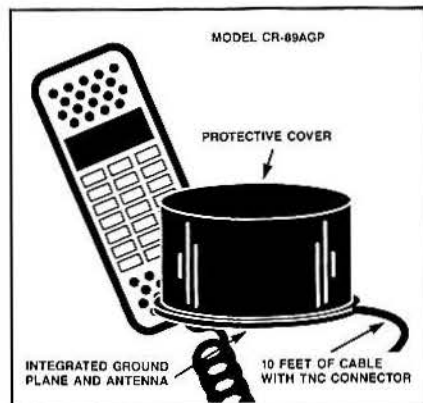
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ZETRON

New products

Enclosed radome covers cellular mobile antenna



An integrated antenna system for cellular usage is available from **Untenna**. The low profile antenna system includes antenna, ground plane, radome cover, coaxial cable and a TNC connector. The CR89AGP system is suited for inside vehicle use, portability and fiberglass mounting.

Circle (407) on Fast Fact Card

Locator service finds stolen vehicles

The stolen vehicle locator service from **International Teletrac** links radiolocation equipment and a transmission network. The service includes 24-hour vehicle monitoring, and the software in-

corporates windows and options that enable a dispatcher to track one vehicle or many units in one city or several.

Circle (450) on Fast Fact Card

Die-cast chassis improves hand-helds

Models 70-145XT and 70-245XT portable radios offer enhanced features such as die-cast chassis, 16-position rotary channel selector switch with stop and a threaded screw-on injection-molded helical antenna. The VHF and UHF **Midland LMR** hand-helds feature improved frequency separation specifications, and a 490MHz-to-512MHz model has been added to the UHF band. The portables retain popular features of the previous models, including switchable 2W or 5W output power.

Circle (405) on Fast Fact Card



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Circle (83) on Fast Fact Card

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- A relaxed atmosphere, conducive to learning, discussing issues, and exchanging ideas (avoiding trade-show conflicts where we only have time for brief new-

product information sessions)

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achieved through cooperation and communication among manufacturers, representatives, and distributors in a maturing industry. All primary links of our marketing chain are included in this annual exchange of ideas.

Plan now to attend CMC 1990, scheduled for November 8-11 at the Embassy Suites Hotel in Denver, Colorado. Space is limited, so make your reservations immediately.

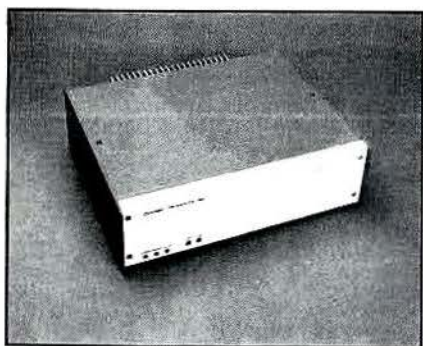
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CMA

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New products

Paging repeater system provides 1W output



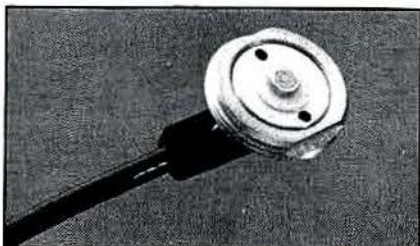
For use in areas where paging signals are blocked by buildings, terrain and other entities, the Page-Link DB8905 paging repeater system fills in. The Decibel Products unit provides 1W of output power. It features an on-off remote control receiver with 5/6-tone decoder, narrowband operation and 1W class C amplifier. Automatic gain control maintains performance over a wide range of input signals.

Circle (415) on Fast Fact Card

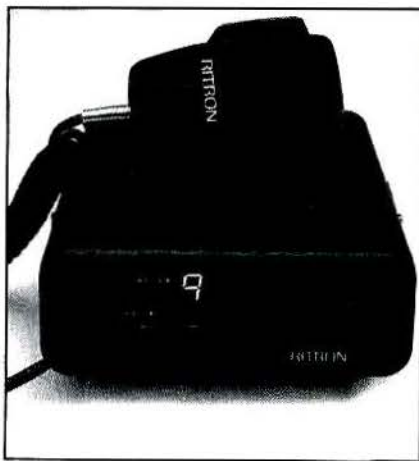
Brass antenna mounts suit 27MHz-to-1,000MHz uses

Brass 3/4-hole antenna mounts feature corrosion resistance and continuity. The Antenex mounts include a shield lug that is soldered to the base rather than crimped. The mounts are recommended for 27MHz-to-1,000MHz applications.

Circle (410) on Fast Fact Card



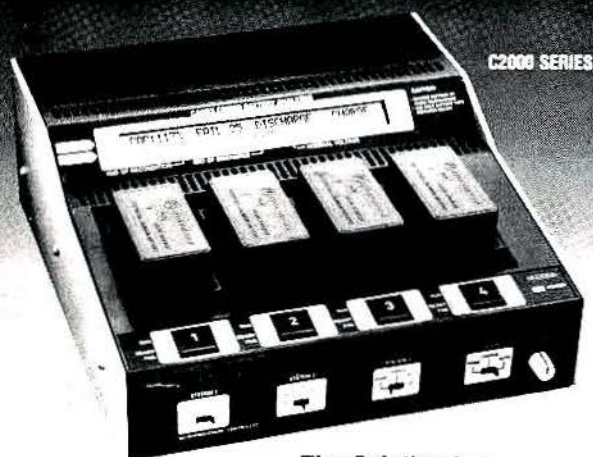
30W VHF mobile spans one to 10 channels



The RPM-150 from Ritron is available in VHF FM. The programmable unit offers one to 10 channels, 30W and a synthesized transmitter. The mobile's cloning feature enables programming of additional mobiles.

Circle (427) on Fast Fact Card

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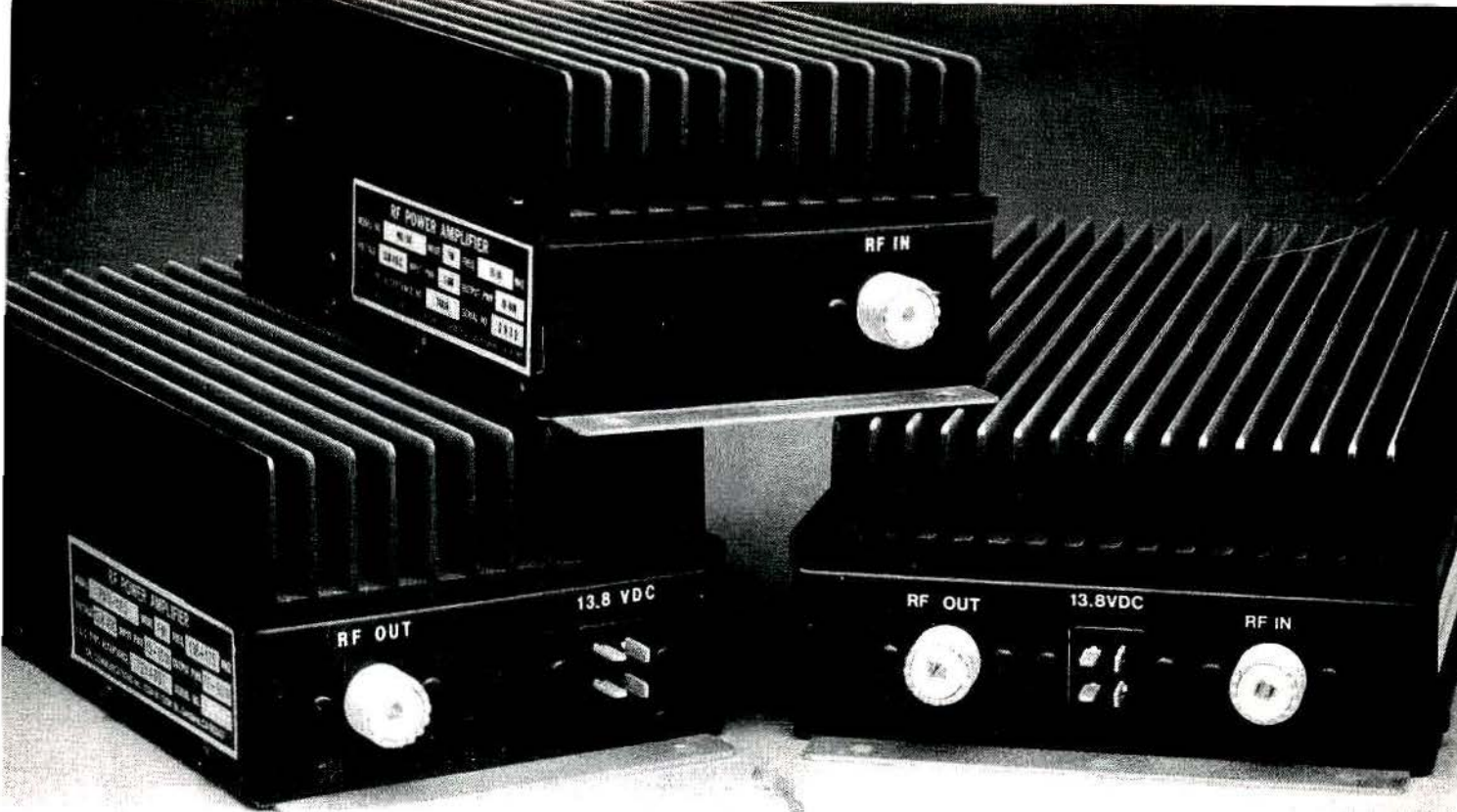
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Circle (86) on Fast Fact Card



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Circle (57) on Fast Fact Card

New products

VHF mobile boasts 48 channels, 25W output



Circle (411) on Fast Fact Card

The LMV2548B VHF mobile radio offers 48 channels and 25W output. The **Relm Communications** mobile is made with an extruded aluminum chassis with a metal case. Features include full function keypad; normal scan; tone and monitor functions; and area scan. The radio has an open channel scan that searches for the first available channel. Signaling options include CTCSS for all 37 standard EIA tones.

Parts tester exults digital readout



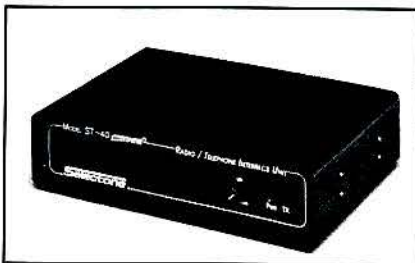
Model 815 hand-held parts tester from **B&K Precision** has a digital readout and tests capacitance and resistance, cable switches, diodes, LEDs and batteries in 26 ranges. The instrument has a tilt stand for bench use and is water-resistant, as well as protected from overload.

Circle (453) on Fast Fact Card

Interface unit upgrade includes 24V talk battery

The ST-40 Hyperdyne radiotelephone interface from **Selectone** includes upgraded features. The enhanced unit includes 24V talk battery; reduced current drain of 1A; audio amplifier; and PTT delay circuit.

Circle (455) on Fast Fact Card



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Circle (89) on Fast Fact Card

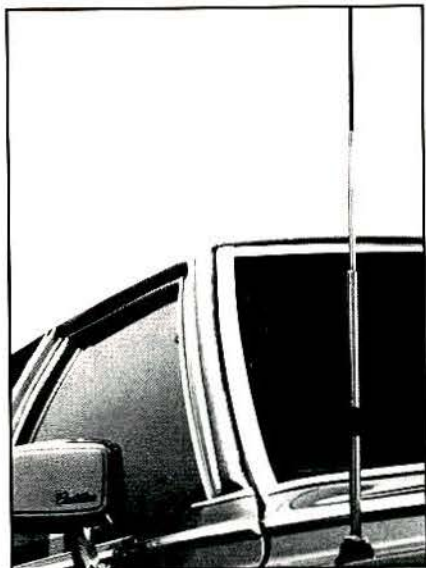
**Dc-to-dc converter
boasts high power density**



Model 1561 dc-to-dc converter from Wilmore Electronics delivers 30A at 24V from a 48V battery. The 800W converter provides input-to-output isolation, tight regulation and output adjustability. The unit has low ripple and noise and includes high power density, high efficiency and a provision for easy paralleling of converters for redundancy or additional power.

Circle (389) on Fast Fact Card

**Cellular, AM/FM antenna
requires no booster amp**

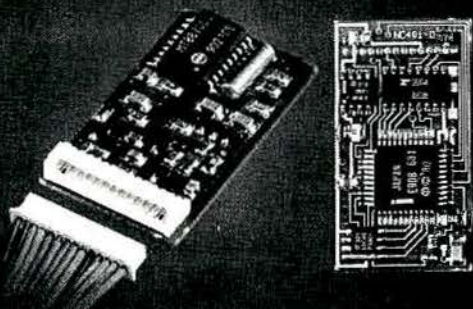


Model CX-400 cellular, AM/FM antenna incorporates a longer mast and no longer requires a booster amplifier for operation as does its predecessor. The Harada Industry of America antenna installs on the fender, and five different angled mounting kits are included for installation.

Circle (408) on Fast Fact Card



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Circle (91) on Fast Fact Card

Catalog features attenuators and switches

JFW Industries' catalog features new products and custom designs for attenuators and switches.

Circle (241) on Fast Fact Card

Report examines mobile, telecommunications

"Radio in the Local Loop" examines leading telephone administrations' experiences of mobile communications by industry group and occupation. The study covers private mobile radio; mobile satellite services; mobile data communications; packet radio; cellular mobile telephone; personal communications network service; paging systems; trunked mobile radios (SMR/PMR); fixed subscriber and rural radio; non-cellular public mobile telephone; and citizen's band radio. Descriptions, histories and forecasts of each technology and service are provided in Dittberner Associates' 800-page report.

Circle (253) on Fast Fact Card

Study discusses European private mobile radio

European mobile radio suppliers face decisions in determining product, service and market strategies in converting private mobile radio (PMR) to public access mobile radio (PAMR), accord-

ing to a Frost & Sullivan report. The study indicates the European marketplace will witness a supply battle for mobile radio.

Circle (406) on Fast Fact Card

Technical bulletin explains desktop comm console

Features, functions and specifications of the Calida 16-channel desktop communications console are outlined in Orbacom's technical bulletin.

Circle (444) on Fast Fact Card

Brochure lists NiCd batteries

A brochure from PowerPak describes Gates' long-life NiCd batteries. The product line, specifications and cross reference material on the sealed, rechargeable NiCd batteries are included in the publication.

Circle (451) on Fast Fact Card

Catalog lists cellular antennas, mounts

Cellular antennas, mounts and accessories are described in a 24-page catalog by Ora Electronics.

Circle (452) on Fast Fact Card

Catalog describes portable antenna

A brochure and selection guide from Antenna Specialists describes Armor-Flex portable replacement antennas. The selection guide provides a cross-reference chart for antenna selection by radio type, connector requirements, frequency and antenna style.

Circle (246) on Fast Fact Card



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Circle (93) on Fast Fact Card

Dealer catalog describes cellular antennas

More than 70 vehicular cellular antennas and accessories are described in **Antenna Specialists'** dealer catalog. Product descriptions and technical specifications for On-Glass, elevated feed, roof-mount, temporary-mount, portable and marine cellular antennas are included in the publication.

Circle (443) on Fast Fact Card

Brochure describes antennas, combiners, filters

Celwave's brochure describes expanded Spectrum antennas, TX combiners, filters and Microcell pattern tailoring antennas that help to optimize MSA systems.

Circle (492) on Fast Fact Card

Manual describes proper grounding technique

A technical manual by **Lightning Eliminators & Consultants** details proper grounding for system equipment. It describes satisfactory grounding for adverse conditions.

Circle (460) on Fast Fact Card

Catalog describes protection, grounding devices

Protection and grounding devices and grounding tutorial information are described in **PolyPhaser's** catalog.

Circle (440) on Fast Fact Card

Buyers' guide lists communications products

Product categories and manufacturer's part numbers are included in **Tessco's** buyers' guide. Cables and connectors; antennas; test equipment; and accessories are included.

Circle (462) on Fast Fact Card

Guide explains shielding effectiveness

Andrew's guide describes shielding effectiveness of coaxial cables, connectors and assemblies. A technical discussion includes transfer impedance and measured transfer impedance data for seven commonly used coaxial cables.

Circle (402) on Fast Fact Card

Brochure describes power system

The Constac 1KVA uninterruptible power system is designed to protect critical ac-operated equipment from blackouts, brownouts and line transients. Electrical and physical specifications are included in the **Lorain Products and Reliance Comm/Tec** brochure.

Circle (442) on Fast Fact Card

Brochure details communications console

Panel switches, panel indicators, individual volume control and channel mute, and extensive patch capability are covered in **Orbacom's** brochure, detailing its TDM-150 distributed microprocessor communications console.

Circle (441) on Fast Fact Card



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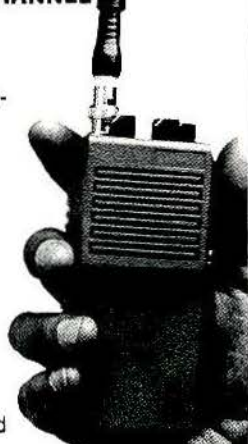
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Circle (94) on Fast Fact Card

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Stiff competition, technological inroads exemplify the '90s

The '90s present competitive challenges, as well as technological ones, according to respondents to the April "What Do You Think?" questionnaire. Marketing will play an ever-increasing role in the competitive arena

in the '90s, readers believe. State-of-the-art developments and integration of ancillary services will propel growth and survival, deem respondents.

The '90s will be more competitive than the '80s according to 75% of the

readers. Statistics include:

Competition	%
Same as the '80s	17.9%
Not as competitive as the '80s	5.4%
More competitive than the '80s	75.0%
No response	1.8%

Readers view foreign competition and giant, dominant companies as survival threats. "A few large companies are buying up the entire marketplace with SMR purchases nationwide," notes a reader.

"As equipment manufacturers proliferate, competition will grow," another comment reads.

"Mass merchandisers will enter land mobile radio, as they did in cellular mobile telephone. Big manufacturers will attempt to kill the land mobile radio guy whenever possible," according to one respondent.

"More acquisitions by larger companies will squeeze small operators out," another respondent wrote.

Other views of the competitive arena include:

- "Improvements in technology for communications and transportation will allow foreign competitors to bring their product here cheaply."

- "Hopefully the Japanese onslaught will wake up all these stupid Americans who currently are too busy with mergermania and hostile takeovers."

- "Emerging technologies will make the industry even more dynamic."

- "Slow growth will put the pressure on prices. New start-ups will stress service, putting added pressure on margins."

- "With more varieties of communications available such as data, personal communications network product and more, the different modes will compete for one person's needs."

- "It is difficult for small companies to keep up with larger ones or pay for technical development."

- "More radio companies and manufacturers are popping up with more versatile equipment—not just one or two."

- "I believe the top two manufactur-

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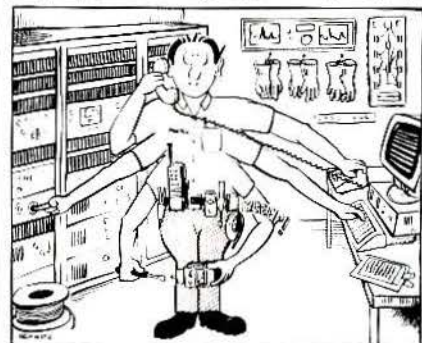
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ers of mobile equipment will change or fall to foreign competition."

- "There is too much money chasing too few good products."

Technical developments

Technical advances readers crave include a personal communications network and smaller batteries. Break-throughs respondents look forward to in the '90s are reported in the following statistics. Multiple responses add up to more than 100%.

Technological development aspirations	%
Smaller batteries	57.1%
Integration of technology such as the wrist-watch pager	33.9%
'Back-to-basics' two-way radio	48.2%
Personal communications network	57.1%
Other	19.6%

In addition to these developments, readers list other items. Technological

wish list items include:

- more RF from smaller packages.
- much more powerful batteries—not smaller.
- encryption developments.
- improved clean coordination.
- video addition over RF.
- improved GMRS radio for personal communications only.
- linked SMR systems.
- extremely efficient subdivision of the spectrum.
- niche systems applying new technologies to present needs.
- trunked UHF—one system fits all—and more lowband frequencies.
- personal VSAT communications for remote and third world populations.

The '90s will not be free of problems, according to many readers. The costs of doing business will accelerate, systems incompatibility will continue, and the lack of enough certified technicians will continue. Respondents cite the following as the biggest problems to confront in the '90s. Multiple responses add up to more than 100%. Statistics include:

Biggest problems faced	%
Lack of enough certified technicians	46.4%
Throw-away product	41.1%
Complicated equipment repairs	39.3%
Salaries	23.2%
Market penetration	10.7%
Costs of doing business	48.2%
Incompatibility among systems	46.4%
Too many trade shows	3.6%
Other	8.9%
No response	3.6%

Readers sent the following comments about problems to be faced in the '90s:

- "There is not enough factory support for technicians."
- "Finding qualified people is already difficult; it won't get much easier."
- "The new technologies will require top-notch technicians to prove themselves."
- "Too many different types of equipment will confuse purchasers."

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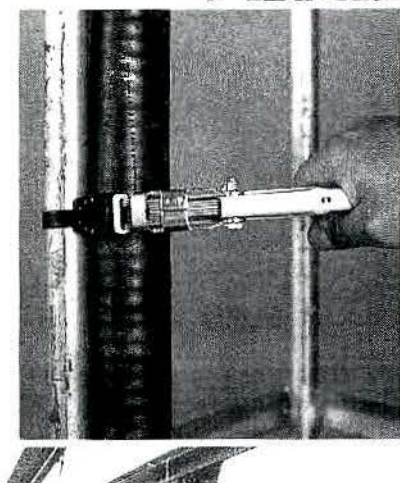
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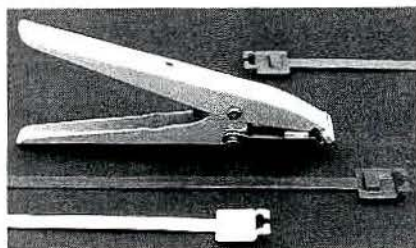


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Feedback

• "With so many players, I see a shakeout in the next few years. Companies with the best marketing organization will survive."

• "Costs will continue to escalate while productivity will not keep pace."

• "Dumping from Asia."

• "Smallness is the key to convenience. This leads to throw-away user install parts. More throw-aways equals litter and no need for replacement parts from OEMs."

• "Good technical help will be difficult to find. The complex technology will make central repair depots more commonplace. Throw-away will degrade the entire industry. Business costs won't be met by low margin profits."

Nationwide and international paging use will be widespread in the '90s, according to 78.6% of the respondents. "As international business grows, the need to reach people overseas will grow," a reader comments.

"For some companies and people, nationwide and international paging will be very valuable. Others will not need this wide coverage area," adds a reader.

"People will require specific geographical areas 90% of the time. Nationwide or international use is limited for purchasers," notes a respondent.

Besides paging, readers view various growth opportunities in land mobile radio. Multiple responses add up to more than 100% as reported in these statistics:

Growth	%
Two-way radio	48.2%
Paging	55.4%
Mobile satellite	37.5%
Mobile data terminals	62.5%
SMR	30.4%
Cellular radio	58.9%
Automatic vehicle location	51.8%
Battery technology	28.6%
Other	8.9%
No response	1.8%



Be sure to fill out this month's "What Do You Think?" questionnaire on page 113 so your responses can be included in a future "Feedback" column.



van der Kaay McLaughlin Townsend Nissen

Erik H. van der Kaay exits Millitech as president to become president of Antenna Specialists, Cleveland.

Greg McLaughlin leaves a vice president and general manager position with an auto aftermarket alarm and sunroof supplier to join AutoPage, Torrance, CA, as customer and technical services manager.

Ron Townsend exits Unipage, De Soto, TX, as eastern regional manager, to join VCP International, Dallas, as national sales manager of the communications division.

Deborah Nissen, a sales representative with Riser-Bond Instruments, Aurora, NE, advances to sales manager of the Aurora branch office.

Election results at the Forest Industries Telecommunications annual meeting: **Peggy Kelly**, Weyerhaeuser, president; **Harry Courtois**, Great Northern Paper, Northern Division vice president; **Ken Clement**, Escanaba Paper, Lake States division vice president; **Tom Keith**, Keith Enterprises, Southern Division vice president; **Lynn Hendry**, Potlatch, Western Division vice president; **Don McConaughy**, Westvaco, treasurer. Staff officers re-elected include **James H. Baker**, executive vice president; and **Kenton Sturdevant**, secretary and assistant vice president.

Stanley A. DeCosmo, general manager of the commercial markets division of Motorola, Schaumburg, IL, advances to corporate vice president of Motorola and president of its Mobile Data International subsidiary, Richmond, British Columbia.

Other promotions at Mobile Data International include: **Steve Flannery**, senior vice president of engineering and manufacturing, advances to executive vice president of operations. **Glen Brownlee**, regional vice president of sales, becomes vice president of sales and systems. **David Sutcliffe** moves up to vice president of marketing.

Joe Gallelli exits Philips Telecom, Maitland, FL, as systems manager to join RAM Mobile Data, New York, as its public safety sales and southern regional manager.

Todd R. Ellis resigns as national sales coordinator for Repco, Orlando, FL, to join Transcrypt International, Lincoln, NE, as director of sales engineering and export sales.



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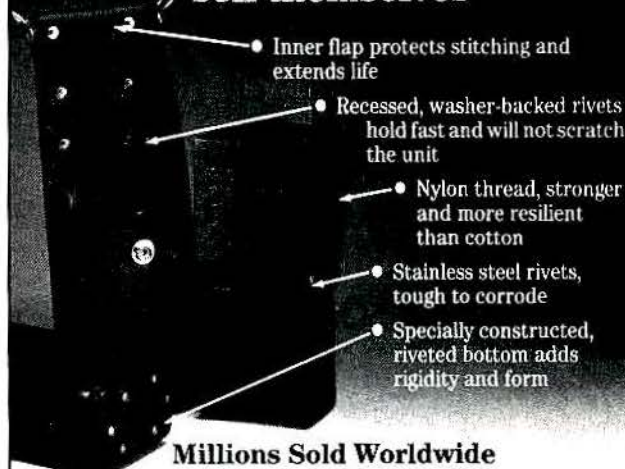
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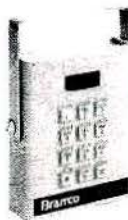
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TOUGH REMOTES THAT ARE TOUGH TO BEAT

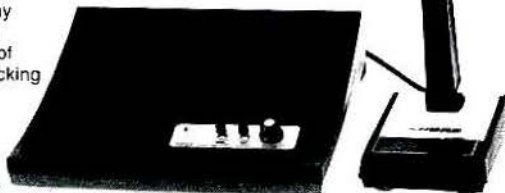
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C alendar

November

8-11—Communications Marketing Conference, Denver. Contact: John Ehret, TPL Communications, 213-256-3000.

16—Radio Club of America Annual Meeting and Awards Banquet, New York Athletic Club, New York. Contact: 201-246-7271.

1991

January

16-18—Cellular Telecommunications Industry Association 1991 Winter Meeting and Exposition, San Diego. Contact: 202-785-0081.

February

25-26—American SMR Network Association New Technologies Symposium and SMR Expo, Westcourt in the Buttes, Phoenix. Contact: 202-331-7773.

March

3-6—Energy Telecommunications and Electrical Association '91, George R. Brown Convention Center and Hyatt Regency, Houston. Contact: 214-235-0655.

11-13—Associated Public-Safety Communications Officers 23rd Western Regional Conference, Red Lion Motel, Salt Lake City. Contact: 801-965-4087.

26-28—International Mobile Communications Expo, Anaheim Convention Center, Anaheim, CA. Contact: 303-220-0600.

April

25-27—Mobilecomm North America, Toronto Convention Center, Toronto, Canada. Sponsored by Telocator and Radiocomm. Contact: 800-422-4862.

May

8-11—National Association of Business and Educational Radio Annual Meeting, Westin O'Hare, Chicago. Contact: 800-759-0300.

19-22—Vehicular Technology Conference, sponsored by IEEE Vehicular Technology Society, Sheraton West Port Inn, Maryland Heights (St. Louis), MO. Contact: Jay Underdown, 314-946-9980.

June

25-27—Utilities Telecommunications Council 43rd Annual Meeting, Hyatt Regency Ohio Center, Columbus, OH. Contact: Rita Clark, 301-621-7802.

July

21-24—Forestry-Conservation Communications Association, Great Smokies Hilton, Asheville, NC. Contact: Don Pfohl, 602-644-3166.

August

12-15—Associated Public-Safety Communications Officers 57th National Conference, Tulsa, OK. Contact: 800-824-1850.

September

19-21—Mobilexpo & Cellular Showcase, Orange County Convention Center/Civic Center, Orlando, FL. Contact: 303-220-0600.

21-25—International Association of Fire Chiefs Annual Meeting, Toronto. Contact: 202-833-3420.

25-28—Special Industrial Radio Service Association Annual Meeting, Hyatt Lake Tahoe, Incline, NV. Contact: Barbara J. Levermann, 703-528-5115.



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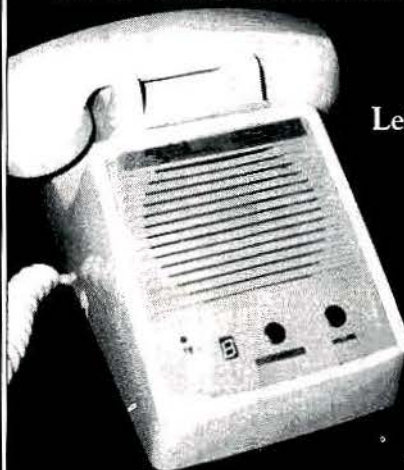
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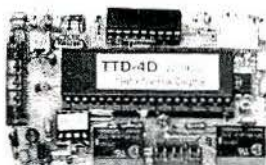


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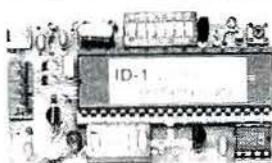
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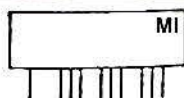
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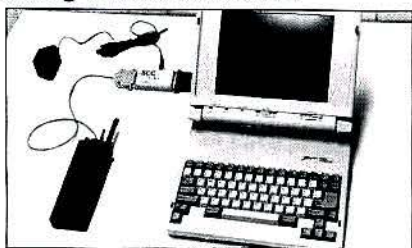
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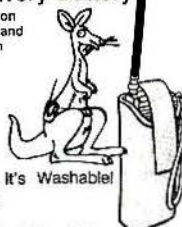
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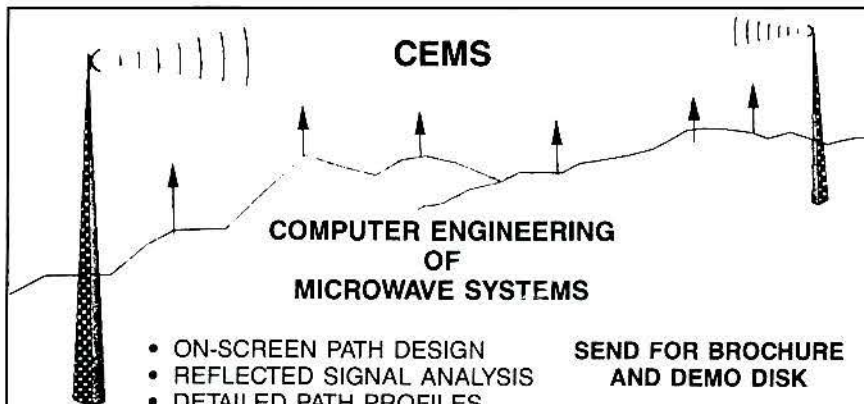
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